The Veliger 42(4):306–337 (October 1, 1999)

THE VELIGER
CMS, Inc., 1999

A Systematic Review of the Hydrobiid Snails (Gastropoda: Rissooidea) of the Great Basin, Western United States. Part II. Genera *Colligyrus, Eremopyrgus, Fluminicola, Pristinicola,* and *Tryonia*

ROBERT HERSHLER

Department of Invertebrate Zoology (Mollusks), NHB STOP 118, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, USA

Abstract. This second and final part of a taxonomic treatment of hydrobiid snails of the Great Basin region in the western United States (based principally on material collected during a recently completed field survey) focuses on fauna other than the genus *Pyrgulopsis.* A new genus of small amnicoline snails, ***Colligyrus,*** is proposed for *Hydrobia greggi* Pilsbry, 1935, together with a new species from the Harney Lake basin of Oregon. This group is strongly differentiated from other amnicolines by a unique female genitalic groundplan. New records are provided for three species of *Fluminicola,* and two new congeners are described from the northwest Great Basin, both of which had previously been confused with *F. turbiniformis* (Tryon, 1865). A new genus of cochliopine snails, ***Eremopyrgus,*** is erected for a new species from Steptoe Valley, Nevada. ***Eremopyrgus*** is distinguished from other cochliopines by unique aspects of its glandular penial lobes and other genitalic features. New records are provided for two species of *Tryonia,* and a new congener is described from thermal springs in central Nevada. Several new records of *Pristinicola hemphilli* (Pilsbry, 1890) from the extreme northwest Great Basin are provided.

INTRODUCTION

In the first part of a systematic review of hydrobiid snails of the Great Basin in the western United States (based principally on material collected during a recently completed field survey), 58 new species belonging to the widespread genus *Pyrgulopsis* were described, and new records were provided for 10 previously described congeners (Hershler, 1998). In this second and final part of this review, other hydrobiid groups, which are much more modestly represented in the region, are similarly treated. Novelties described herein include two small species of *Fluminicola* from the northwest Great Basin previously confused with *F. turbiniformis* (Tryon, 1865), a species of *Tryonia* from central Nevada, a new genus of cochliopine snails from eastern Nevada, and a new genus of small amnicoline snails from northern segments of the Great Basin.

The reader is referred to Hershler (1998) for study rationale and methodology. Institutional repositories of examined specimens are indicated by the following abbreviations: ANSP, Academy of Natural Sciences, Philadelphia; CAS, California Academy of Sciences, San Francisco; FMNH, Field Museum of Natural History, Chicago; USNM, former United States National Museum, collections now in National Museum of Natural History, Smithsonian Institution, Washington, D.C. Shell parameters for new species are summarized in Table 1.

SYSTEMATICS

Family Hydrobiidae Troschel, 1857

Colligyrus, Hershler, gen. nov.

Type species: *Hydrobia greggi* Pilsbry, 1935. Also included is ***Colligyrus depressus,*** sp. nov. (described below).

Etymology: From New Latin, *collis,* hill or high ground; and *gyrus,* circle or round. Referring to the upland habitat and coiled shell of these snails. Gender masculine.

Diagnosis: A northwestern American amnicoline group having a small, globose to conical shell and paucispiral operculum. Female coiled oviduct simple; glandular oviduct large, ventrally closed; bursa copulatrix large, posteriorly positioned; seminal receptacles, 2.

Description: Shell small (up to 3.3 mm in length), thin, globose to conical, umbilicate. Whorls, 3.5–4.5, convex, narrowly shouldered, sutures impressed. Shell clear to white, periostracum thin. Shell apex nearly flat; protoconch of about 1.5 whorls, sculptured with weak spiral lineations. Teleoconch smooth except for faint growth lines. Aperture medium-sized, ovate or circular; outer lip thin; parietal lip complete across body whorl, thin; columellar lip sometimes slightly thickened. Umbilicus narrow to perforate. Operculum flat, thin, ovate, paucispiral. Outer margin of operculum without rim; attachment scar and callus weakly developed. Body pigmentation well de-

Table 1

Selected shell parameters for new species. Data expressed as mean with standard deviation given below. Measurements are given in mm. *n* = number of specimens, μ = mean, SD = standard deviation, SH = shell height, SW = shell width, HBW = height of body whorl, WBW = width of body whorl, AH = aperture height, AW = aperture width, SS = shell width/shell height, WH = number of shell whorls.

		SH	SW	HBW	WBW	AH	AW	SS	WH
Colligyrus depressus									
USNM 860756	μ	1.98	1.78	1.73	1.52	1.05	0.93	0.90	3.60
n = 15	SD	0.05	0.06	0.04	0.03	0.05	0.04	0.03	0.13
Fluminicola ***insolitus***									
USNM 860757	μ	4.55	3.86	3.88	3.13	2.59	2.30	0.85	3.78
n = 13	SD	0.25	0.18	0.18	0.17	0.12	0.15	0.03	0.09
Fluminicola ***virginius***									
USNM 874902	μ	3.19	2.85	2.81	2.08	1.88	1.64	0.89	3.48
n = 15	SD	0.13	0.08	0.11	0.08	0.10	0.09	0.03	0.22
Eremopyrgus eganensis									
USNM 874692	μ	3.44	1.89	2.35	1.71	1.57	0.96	0.55	4.78
n = 15	SD	0.21	0.09	0.11	0.07	0.12	0.05	0.02	0.23
Tryonia ***monitorae***									
USNM 892046	μ	3.87	1.39	1.72	1.34	1.04	0.71	0.36	7.02
n = 15	SD	0.19	0.07	0.10	0.07	0.05	0.05	0.01	0.20
USNM 874882	μ	3.87	1.38	1.68	1.30	1.01	0.67	0.36	6.98
n = 14	SD	0.28	0.08	0.09	0.08	0.06	0.05	0.02	0.32

veloped. Salivary glands long, simple tubes. Radula ribbon elongate (ca. 15 times longer than wide), coiled behind buccal mass. Cutting edge of central teeth straight or weakly concave, bearing 9–15 short cusps. Central cusp pointed, slightly larger than lateral cusps. Basal cusps, 1–2 (sometimes absent on one side), innermost cusp largest. Lateral margins of central teeth angled about 40° to vertical axis of tooth, slightly thickened, distally expanded, projecting slightly beyond V-shaped base of tooth. Lateral teeth with 2–4 inner cusps and 3–5 outer cusps; basal process well developed. Lateral wing of lateral teeth rather broad, somewhat longer than cutting edge. Marginal teeth with relatively numerous cusps; cusps on inner marginals larger than those on outer marginals. Dorsal folds of esophagus short, straight. Cephalic tentacles medium length in preserved material. Ctenidium absent, reduced to a vestige, or well developed, with small, triangular filaments. Osphradium medium-sized, narrow. Hypobranchial gland well developed along rectum. Renal organ with prominent pallial bulge. Stomach longer than style sac, posterior caecal appendix absent; anterior stomach chamber larger than posterior chamber. Rectum straight in pallial roof. Cephalo-pedal ganglia weakly pigmented; cerebral and pedal commissures short. Testis large. Prostate gland small, walls of medium thickness. Penis small to medium-sized relative to head, bifurcate. Lobe slightly shorter than filament, arising from inner edge at or near base, usually posteriorly oriented, weakly folded along most of length. Lobe containing weakly coiled duct which enters small muscular sac distally and exits as eversible papilla through cup-shaped opening. Duct exits base of lobe into nuchal cavity, broadening to form a large mass of blindly ending glandular loops above the salivary glands; gland lined with thin muscular coat. Penial filament straight or coiled to left, tapering to pointed tip. Penial duct medium width, with thick muscular coat, straight or weakly undulating basally, positioned along outer edge of filament. Females oviparous. Ovary small. Glandular oviduct consisting of sub-equal albumen and capsule glands. Albumen gland with short pallial component. Coiled oviduct a single, posteriorly arched loop opening to anterior portion of albumen gland. Bursa copulatrix medium-sized, positioned posteriorly, partly overlapped by albumen gland. Bursal duct ciliated, short to medium length, originating from anterior edge, opening to oviduct slightly behind pallial wall. Posterior seminal receptacle pouchlike, opening to distal arm of coiled oviduct; anterior seminal receptacle ovate to circular, pressed against ventral edge of albumen gland, opening to oviduct just distal to connection with bursal duct. Capsule gland with narrow, vertical lumen. Sperm tube narrow, separated from capsule gland along most of length, but distally fused to form common genital aperture.

Remarks: The small anterior female accessory pouch has a cellular structure similar to that of the posterior seminal receptacle and, although sperm was not seen in sectioned material, the pouch nevertheless is interpreted as a seminal receptacle. ***Colligyrus*** differs from other amnicolines in that females have three sperm pouches: a posterior bursa copulatrix and two small seminal receptacles. In con-

trast, a group composed of *Dasyscias, Lyogyrus,* and *Parabythinella* has but a single, posterior sperm pouch (e.g., Thompson & Hershler, 1991:fig. 11 [*Dasyscias franzi* Thompson & Hershler, 1991]), which represents a bursa copulatrix based on its columnar cell lining and absence of oriented sperm in its lumen (Hershler, unpublished); while a second group composed of *Amnicola* and *Marstoniopsis* has a posterior bursa copulatrix and a single large seminal receptacle (e.g., Hershler & Thompson, 1988:fig. 8 [*Amnicola limosa* (Say, 1817)]).

Although the type species of ***Colligyrus*** resembles *Lyogyrus* (to which it was most recently allocated) in its diminutive conical shell, ***Colligyrus*** nevertheless is more similar to *Amnicola* in female genitalic groundplan, although it differs in having two (as opposed to a single) seminal receptacles. ***Colligyrus*** and *Amnicola* have a weaker protoconch microsculpture than *Lyogyrus* and also share a paucispiral (as opposed to multispiral) operculum. The anterior seminal receptacle of ***Colligyrus*** may be homologous to that of *Amnicola*, as both of these sacs open to the oviduct distal to the coiled portion at or near the junction of the bursal duct (the posterior seminal receptacle of ***Colligyrus*** opens to the distal arm of the coiled oviduct as in most hydrobiids). Note, however, that these sacs otherwise differ in their size, shape, and position. ***Colligyrus*** also differs from *Amnicola* in having diffuse rather than banded pigment on the dorsal surface of the mantle, a much more elongate radula, narrower central cusps on the central and lateral radular teeth, more numerous cusps on the marginal radular teeth, and a more basal position of the penial lobe.

Colligyrus lives in cold springs and spring runs in the upper Snake River basin and northeastern (Bonneville basin) and northwestern (Harney Lake basin) portions of the Great Basin.

Colligyrus greggi (Pilsbry, 1935)

(Figures 1, 2A–D, 3A, 5)

Hydrobia greggi Pilsbry, 1935:93–94, fig. 2.—Henderson, 1936:138, fig. 9.—Baker, 1964:173.—Beetle, 1957: 19.—Beetle, 1961:5.—Beetle, 1989:639.

Amnicola greggi (Pilsbry, 1935), Taylor, 1966b:173.—Taylor, 1975:90 (literature compilation).—Turgeon et al., 1988:60.

Amnicola (Lyogyrus) greggi (Pilsbry, 1935), Burch & Tottenham, 1980:124, figs. 292, 303.

Diagnosis: Small to medium-sized, with conical shell.

Description: Shell (Figure 1A) conical; height, 1.7–3.3 mm; whorls, 3.75–4.5. Protoconch (Figure 1B, C) of about 1.5 whorls, diameter about 0.49 mm; microsculpture of numerous weakly incised spiral lineations. Teleoconch whorls weakly convex, adapical shoulder often well developed. Shell clear to white, often transparent. Periostracum light brown or tan. Aperture ovate or circular, without adapical angulation. Outer lip weakly prosocline, thin to moderately thick. Parietal lip narrowly adnate to well separated from body whorl. Umbilicus narrow to perforate; columellar swelling absent to narrow.

Operculum (Figure 1D, E) light amber; outer margin without rim, dorsal surface weakly frilled. Attachment scar slightly thickened all around, especially along inner edge. Callus weakly developed.

Radula with about 155 rows of teeth; ribbon length, 1.5 mm, ribbon width, 94 μm; central tooth width, 25 μm. Cutting edge of central tooth (Figure 1F) straight or very weakly indented; lateral cusps, 4–7; median cusp pointed, slightly broader and longer than laterals; basal cusps, 1–2; basal tongue narrowly triangular, even with or slightly shorter than lateral margins, basal sockets moderately excavated. Lateral tooth (Figure 1G) with slightly convex dorsal edge; lateral wing longer (150%) than cutting edge; tooth face taller than broad; central cusp weakly pointed, lateral cusps, 2–4 (inner), 3–4 (outer). Inner marginal teeth (Figure 1H) with 24–27 cusps; outer marginal teeth (Figure 1I) with 25–33 cusps.

Tentacles light gray to black. Snout light gray. Foot pale, opercular pale or fringed with medium gray pigment. Neck pale or pigmented with scattered gray granules. Pallial roof, visceral coil black.

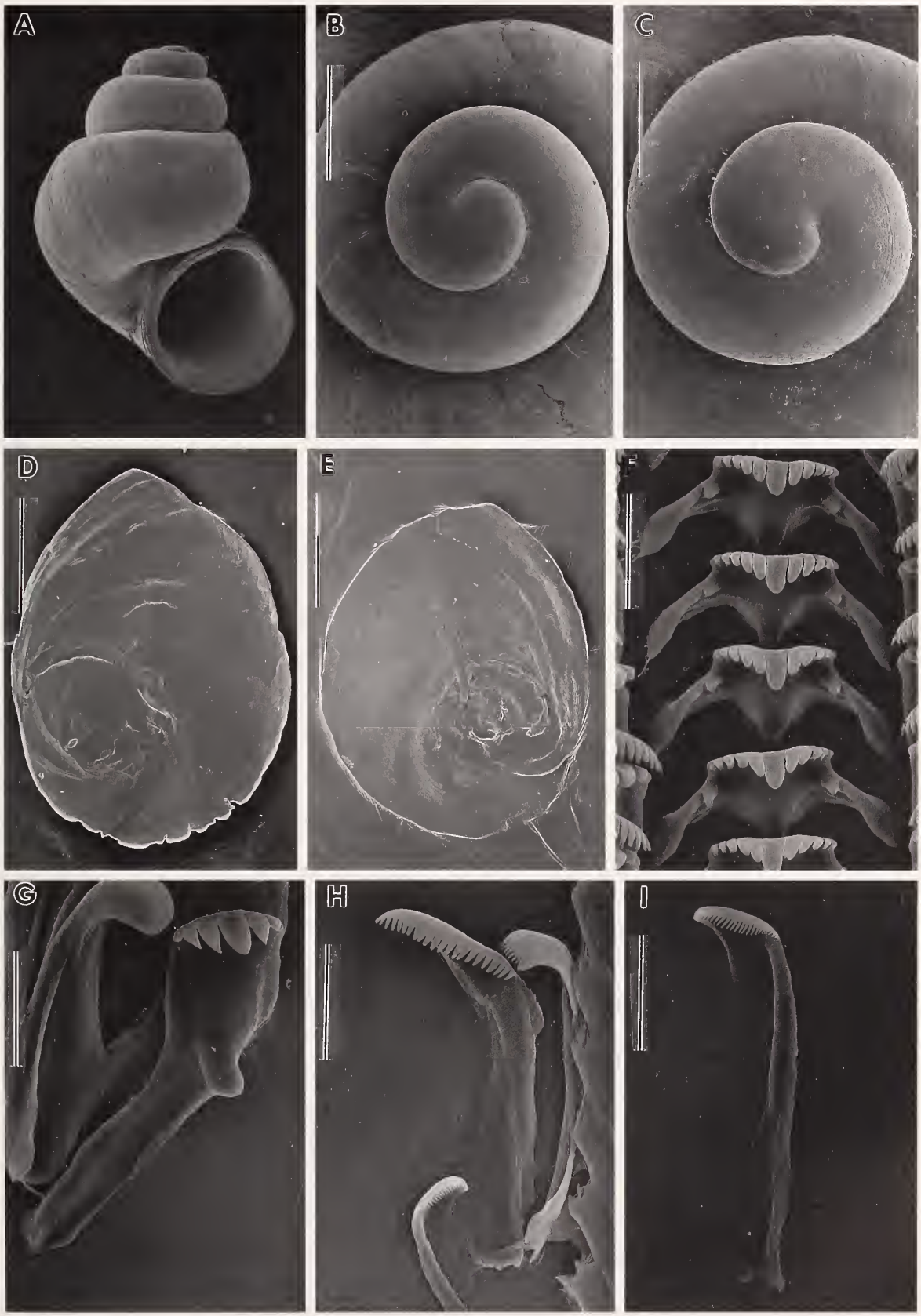
Ctenidium well developed, slightly overlapping pericardium; filaments about 17, small, about as tall as wide, weakly pleated. Osphradium about 33% of ctenidium length, positioned centrally or slightly posterior to middle of ctenidium.

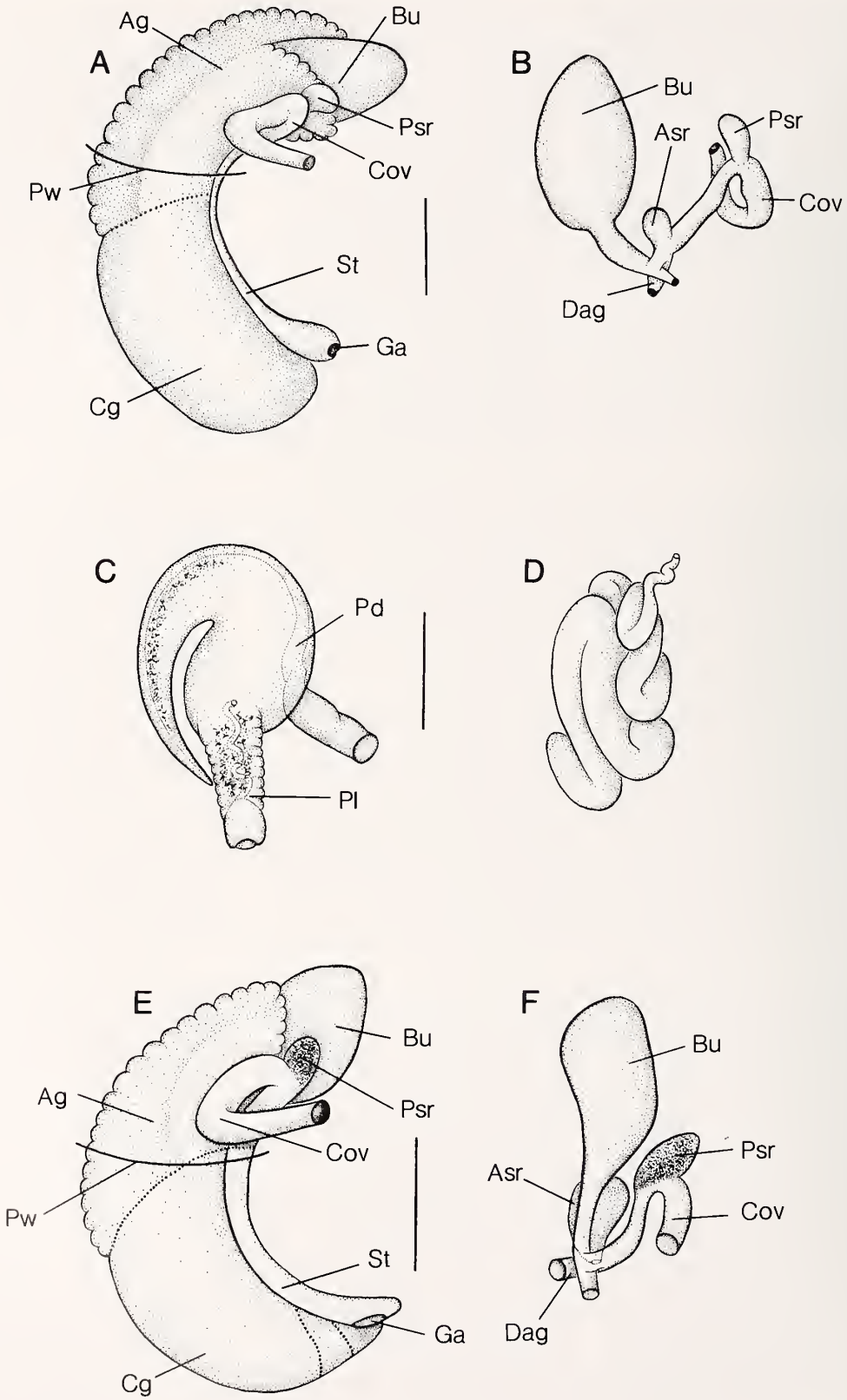
Ovary slightly less than 0.5 whorl, abutting posterior edge of stomach, filling less than 50% of digestive gland behind stomach. Distal female genitalia shown in Figure 2A, B. Bursa copulatrix about 67% of length of albumen gland; narrowly ovate, horizontal, with about half of length overlapped by albumen gland. Bursal duct short (about 33% of length of bursa copulatrix), distinctly nar-

→

Figure 1

Scanning electron micrographs of shell, operculum, and radula of ***Colligyrus greggi*** Hershler, gen. nov., USNM 883531. A. Shell (height 2.3 mm). B, C. Shell apex. Bars = 200 μm, 160 μm, respectively. D. Operculum, outer surface. Bar = 270 μm. E. Operculum, inner surface. Bar = 285 μm. F. Central radular teeth. Bar = 12 μm. G. Lateral radular tooth. Bar = 13 μm. H. Inner marginal tooth. Bar = 13 μm. I. Outer marginal tooth. Bar = 12.5 μm.


A
B
C
D
E
F
G
H
I


A
Ag
Bu
Psr
Cov
Pw
St
Ga
Cg
B
Bu
Asr
Psr
Cov
Dag
C
Pd
Pl
D
E
Bu
Ag
Psr
Cov
Pw
St
Ga
Cg
F
Bu
Psr
Asr
Cov
Dag

rower than bursa copulatrix. Posterior seminal receptacle a small, ovate sac (with short duct) overlapping the bursa copulatrix, sometimes overlapped anteriorly by albumen gland. Posterior seminal receptacle abutting the posterior edge of the coiled oviduct, opening to the postero-ventral edge of this duct. Anterior seminal receptacle a somewhat smaller, nearly circular sac; duct absent or very short. Albumen gland with a weak rectal furrow; furrow absent on capsule gland. Albumen gland with short (20%) pallial component. Capsule gland about as long and wide as albumen gland. Anterior portion of sperm tube expanded into vestibule; genital opening a small, terminal pore.

Testis 1.25 whorls, filling more than 50% of digestive gland behind stomach. Prostate gland bean-shaped, with about 38% of length in pallial roof. Distal vas deferens a broad, thickened tube, slightly undulating in pallial roof and neck. Penis shown in Figure 2C; tubular gland shown in Figure 2D. Penial lobe arising from base. Penial duct narrowing somewhat in base of penis; undulating basally, otherwise straight. Penis pigmented with scattered internal granules; base sometimes darkly pigmented with melanin.

Type locality: Cliff Creek canyon, a fork of Hoback Canyon, about 29 miles (46 km) south of Jackson, Wyoming, in the Snake River drainage. The type locality has not been precisely located. A spring in Cliff Creek canyon harboring this species is shown in Figure 4A. Lectotype, ANSP 163812 (Figure 3A); paralectotypes, ANSP 375735. Baker (1964) separated the single figured specimen and identified this as the "type by original measurement," which is construed as a lectotype designation.

Remarks: This snail lives in the upper Snake River basin and northeastern corner of the Great Basin (Bonneville basin) (Figure 5). Records from western Montana (Taylor 1966b:173) require confirmation. Populations assigned to this species vary slightly in shell shape, relationship between aperture and body whorl, and thickness of shell lip. Taylor (1966b:173) reported laminate egg capsules (typical of amnicoline snails) for this species.

Material examined: IDAHO. *Bannock County:* Heart Mtn. Spring, Marsh Valley, T. 13 S, R. 39 E, NW ¼ section 2, USNM 883881. *Bear Lake County:* spring, Right Fork Georgetown Canyon, Bear River drainage, T. 11 S, R. 44 E, NW ¼ section 10, USNM 883522.—spring, Home Canyon, Bear River drainage, T. 12 S, R. 45 E, NW ¼ section 32, USNM 883524. *Caribou County:* Harris Spring complex, Bear River drainage, T. 11 S, R. 41 E, NE ¼ section 9, USNM 883394.—Kackley Spring, Bear River drainage, T. 10 S, R. 40 E, SW ¼ section 21, USNM 883539.—spring, Kelly Park, Soda Springs, Bear River drainage, T. 9 S, R. 42 E, NW ¼ section 5, USNM 883523. *Franklin County:* spring, Cottonwood Creek, Bear River drainage, T. 12 S, R. 39 E, NE ¼ section 25, USNM 883392. **UTAH.** *Cache County:* China Row Spring, Logan Canyon, Cache Valley, T. 12 N, R. 3 E, NE ¼ section 7, USNM 858288, USNM 883393.—spring, east of Porcupine Reservoir, Cache Valley, T. 9 N, R. 2 E, NW ¼ section 17, USNM 883880. **WYOMING.** *Lincoln County:* spring, Sublette Creek, Bear River drainage, T. 24 N, R. 118 W, NW ¼ section 8, USNM 883396.—spring, Salt Creek, Bear River drainage, T. 29 N, R. 119 W, SW ¼ section 24, USNM 883395. *Sublette County:* spring, Cliff Creek, Snake River drainage, T. 38 N, R. 114 W, NW ¼ section 23, USNM 883531.

Colligyrus depressus Hershler, sp. nov.

Harney Basin duskysnail
(Figures 2E, F, 3B, 5, 6)

Etymology: from New Latin, *depressus,* meaning pressed down, low, and referring to the squat shell of this species.

Diagnosis: Small, with globose to low-conic shell.

Description: Shell (Figure 6A) low-conic, rarely with eroded spire; height, 1.9–2.1 mm; whorls, 3.5–3.75. Apex often inclined; protoconch (Figure 6B, C) of 1.4–1.5 whorls, diameter about 0.44 mm; microsculpture of numerous weak spiral lineations. Teleoconch whorls convex, often markedly so, narrowly shouldered. Shell clear to white, translucent. Periostracum tan. Aperture medium-sized, ovate, weakly angled adapically. Outer lip prosocline, weakly sinuate (adapically advanced). Parietal lip narrowly adnate to or slightly separated from body whorl; columellar lip without swelling. Umbilicus perforate.

←

Figure 2

Genitalia of ***Colligyrus*** Hershler, gen. nov., species (A–D, ***C. greggi,*** USNM 883531; E, F, ***C. depressus*** Hershler, gen. & sp. nov., USNM 860756). A. Left side of female glandular oviduct and associated structures. Bar = 0.5 mm. B. Bursa copulatrix and associated structures. Scale as in "A." C. Dorsal surface of penis. Bar = 0.25 mm. D. Tubular gland (coiled within cephalic haemocoel). Scale as in "C." E. Left side of female glandular oviduct and associated structures. Bar = 0.25 mm. F. Bursa copulatrix and associated structures. Scale as in "E." Ag, albumen gland; Asr, anterior seminal receptacle; Bu, bursa copulatrix; Cg, capsule gland; Cov, coiled oviduct; Dag, opening of oviduct to albumen gland; Ga, genital aperture; Pd, penial duct; Psr, posterior seminal receptacle; Pw, posterior wall of pallial cavity; St, sperm tube.

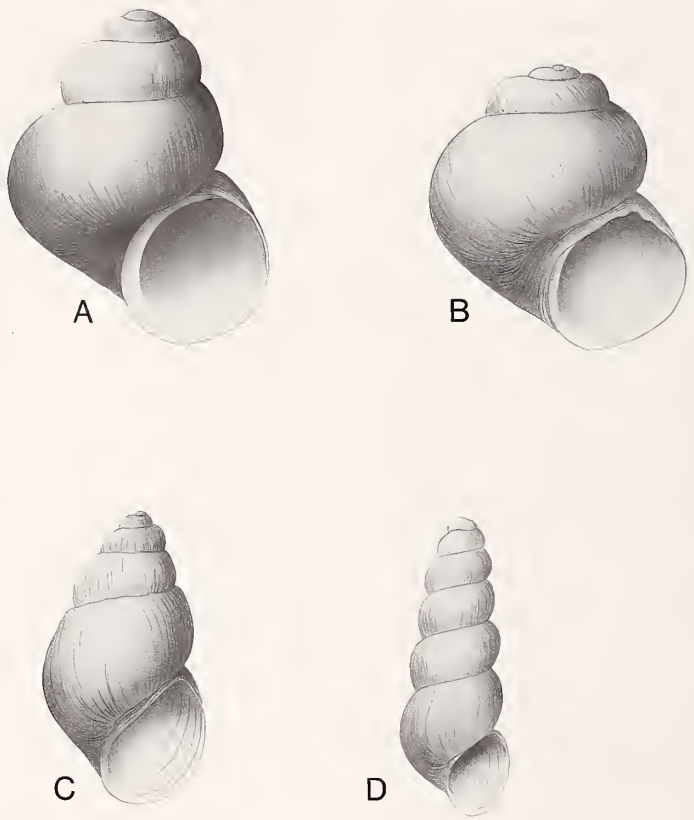


Figure 3

Type material of Great Basin species of ***Colligyrus*** Hershler, gen. nov., ***Eremopyrgus*** Hershler, gen. nov., and *Tryonia*. A. ***C. greggi,*** lectotype, ANSP 163812 (shell height 2.6 mm). B. ***C. depressus*** Hershler, gen. & sp. nov., holotype, USNM 883876 (1.7 mm). C. ***E. eganensis*** Hershler, gen. & sp. nov., holotype, USNM 874692 (3.1 mm). D. *T.* ***monitorae*** Hershler, sp. nov., holotype, USNM 892046 (3.0 mm).

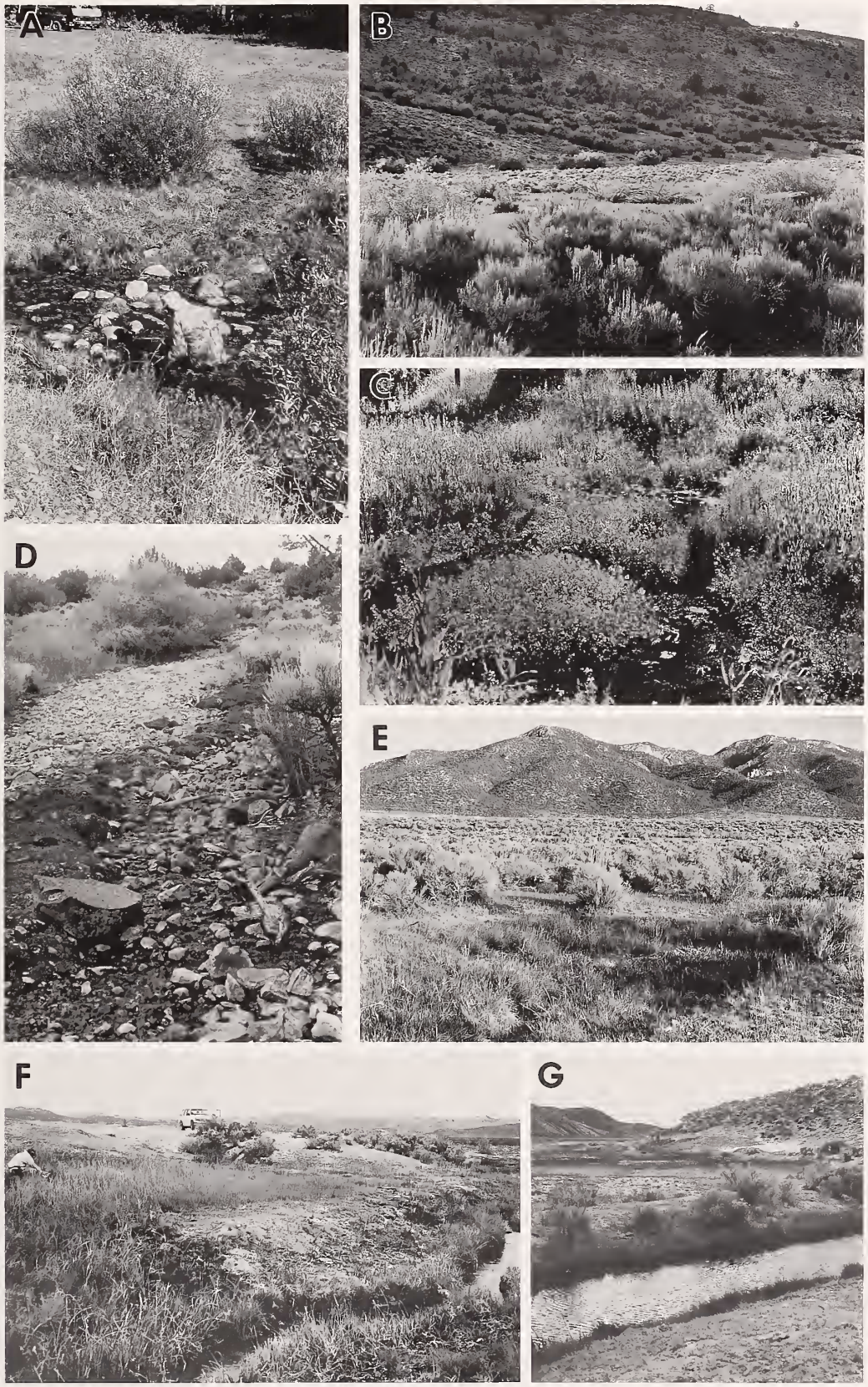
Operculum (Figure 6D, E) brown in nuclear region, otherwise clear; outer margin without rim. Attachment scar margin slightly thickened along inner edge. Callus weakly developed in nuclear region.

Radula with about 170 rows of teeth; ribbon length, 1.4 mm, ribbon width, 88 μm; central tooth width, 22 μm. Cutting edge of central tooth (Figure 6F) weakly to moderately indented; lateral cusps, 6–7; median cusp rounded or weakly pointed, slightly broader and longer than laterals; basal cusps, 1, sometimes absent on one side; basal tongue slightly shorter than lateral margins, basal sockets deeply excavated. Lateral tooth (Figure 6G) with horizontal or slightly convex cutting edge; lateral wing slightly longer (125%) than cutting edge; tooth face

→

Figure 4

Type and other localities for species treated herein. A. Spring, Cliff Creek, Snake River drainage, Sublette County, Wyoming. Habitat of ***Colligyrgus greggi*** Hershler, gen. nov. in vicinity of type locality. Photograph, September, 1993. B. Springs, Cricket Creek, Silvies River drainage, Harney County, Oregon. Type locality of ***C. depressus*** Hershler, gen. & sp. nov. Photograph (D. Sada), July, 1994. C. Page Springs, Donner und Blitzen River drainage, Harney County, Oregon. Type locality of *Fluminicola* ***insolitus*** Hershler, sp. nov. Photograph (D. Sada), July, 1993. D. "Waterfall" spring, source of Hardscrabble Creek, Pyramid Lake basin, Washoe County, Nevada. Type locality of *F.* ***virginius*** Hershler, sp. nov. Photograph (G. Vinyard), October, 1992. E. Spring northwest of Clark Spring, Steptoe Valley, White Pine County, Nevada. Type locality of ***Eremopyrgus eganensis*** Hershler, gen. & sp. nov. Photograph, June, 1992. F. Hot Springs, Potts Ranch, Monitor Valley, Nye County, Nevada. Type locality of *T.* ***monitorae*** Hershler, sp. nov. Photograph (D. Sada), November, 1992. G. Dianas Punch Bowl (Hot Springs), Monitor Valley, Nye County, Nevada. Habitat of *T.* ***monitorae*** Hershler, sp. nov. Photograph (D. Sada), November, 1992.


A
B
C
D
E
F
G

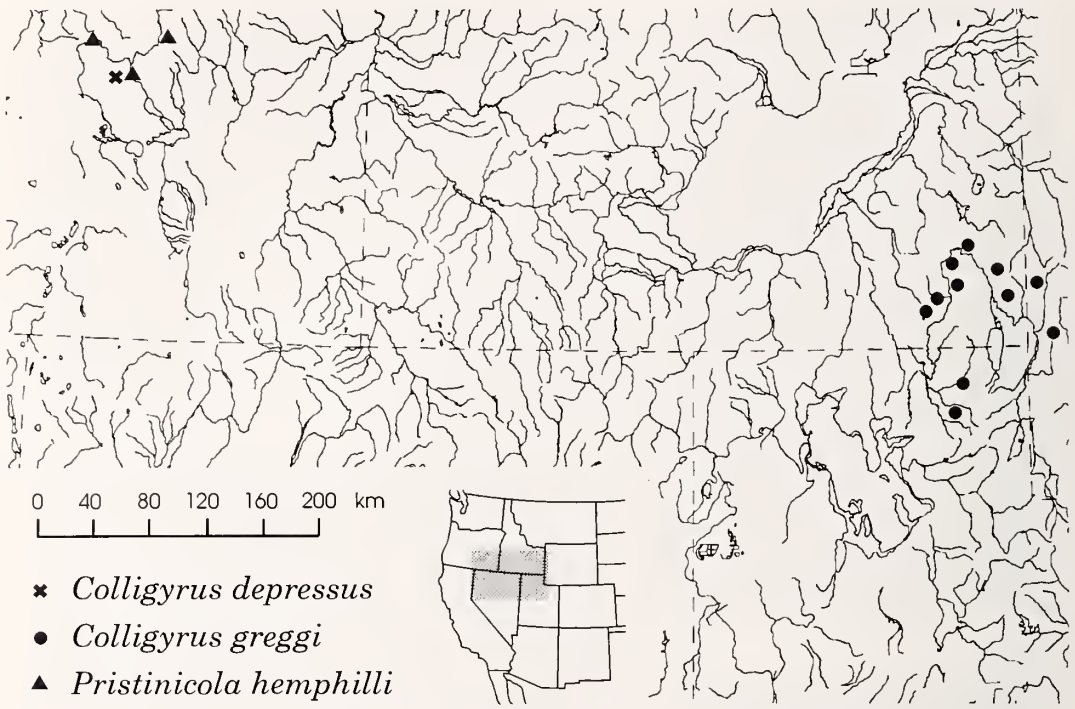


Figure 5

Map of northern Great Basin and adjacent regions showing the distribution of ***Colligyrus*** Hershler, gen. nov. species and *Pristinicola hemphilli*. Previously reported localities for *Pristinicola hemphilli* (see Hershler et al., 1994) are not shown.

taller than broad; central cusp rounded, lateral cusps, 3 (inner), 4–5 (outer). Inner marginal teeth (Figure 6H) with 26–30 cusps; outer marginal teeth (Figure 6I) with 25–29 cusps.

Snout, tentacles, foot light to medium gray. Inner edge of opercular lobe black. Neck unpigmented to medium gray. Pallial roof, visceral coil medium gray to black.

Ctendium absent or represented by a few (3–6) small, stubby vestiges; branchial vessel not seen in dissection. Osphradium anteriorly positioned, filling about 20% of pallial cavity length.

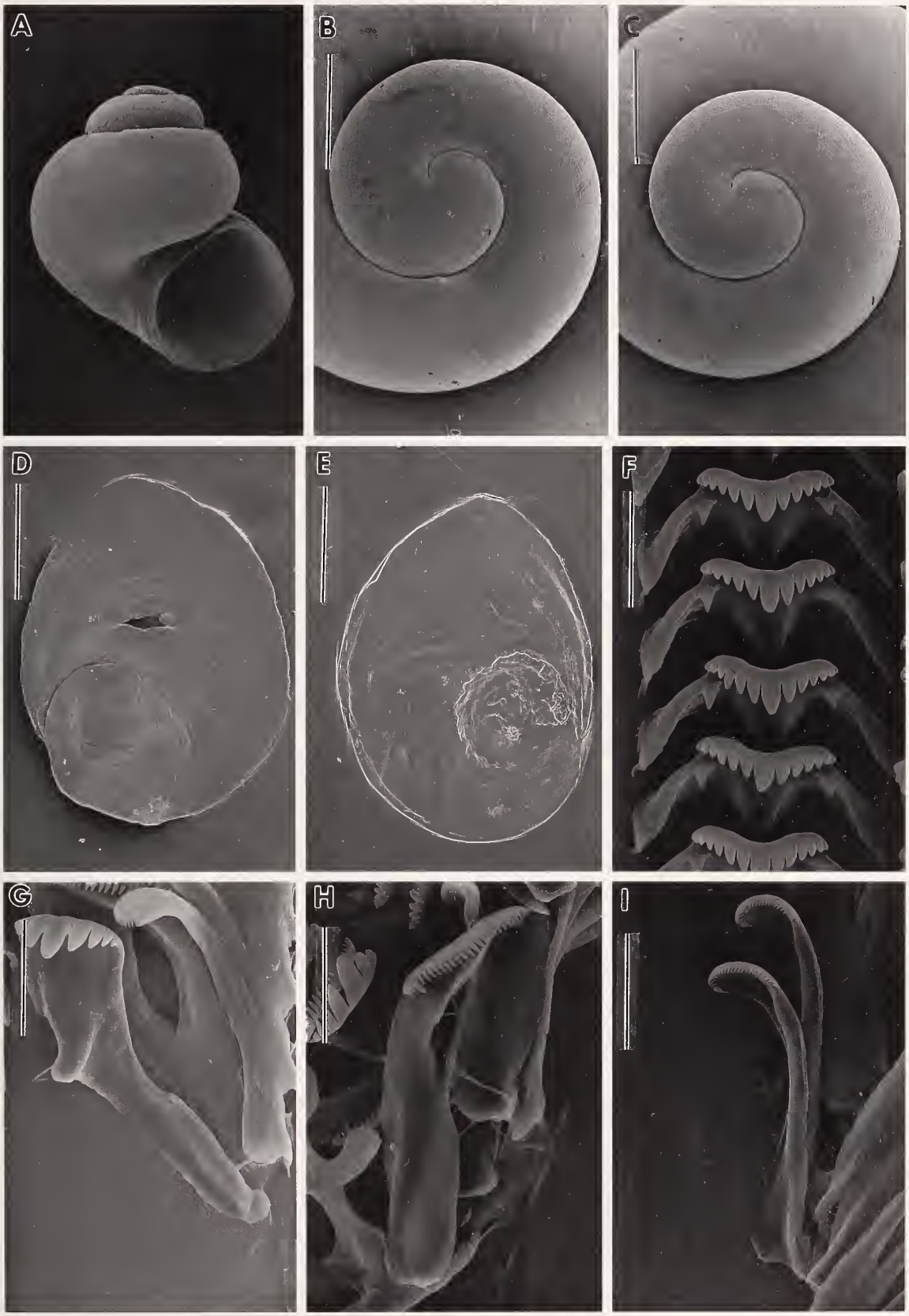
Ovary about 0.5 whorl, abutting or slightly overlapping posterior stomach chamber, filling less than 50% of digestive gland behind stomach. Distal female genitalia shown in Figure 2E, F. Bursa copulatrix about 50% of albumen gland length; ovate or clublike, horizontal or obliquely oriented, about 50% overlapped by albumen gland. Bursal duct medium length (50–67% of bursa length), often narrow, sometimes poorly distinguished from bursa. Posterior seminal receptacle small, without duct, overlapping anterior half of bursa copulatrix, positioned near ventral edge of albumen gland. Portions of coiled oviduct adjacent to posterior seminal receptacle often filled with sperm. Anterior seminal receptacle disc-shaped. Albumen gland with weak rectal furrow. Albumen gland with short (about 22%) pallial section; capsule gland entirely pallial, composed of two distinct glandular units. Genital opening a small terminal slit.

Testis 1.0–1.25 whorl, broadly overlapping stomach chambers, filling about 50% of digestive gland behind stomach. Prostate gland ovate, entirely visceral. Pallial vas deferens a broad tube without bends or undulations;

→

Figure 6

Scanning electron micrographs of shell, operculum, and radula of ***Colligyrus depressus*** Hershler, gen. & sp. nov. USNM 860756. A. Shell (height 1.8 mm). B, C. Shell apex. Bars = 170 μm, 188 μm, respectively. D. Operculum, outer surface. Bar = 230 μm. E. Operculum, inner surface. Bar = 240 μm. F. Central radular teeth. Bar = 10 μm. G. Lateral radular tooth. Bar = 13 μm. H. Inner marginal tooth. Bar = 12.5 μm. I. Outer marginal teeth. Bar = 11.5 μm.


A
B
C
D
E
F
G
H
I

portion of vas deferens in neck straight. Penial lobe arising slightly distal to base. Penial duct narrow throughout. Penis unpigmented.

Type locality: Unnamed springs, Cricket Creek, Silvies River drainage, Harney County, Oregon, T. 21 S, R. 28 E, NW ¼ section 12. The type locality is composed of a series of small, cold rheocrenes (11°C, 81 micromhos/cm) (Figure 4B). Holotype, USNM 883876 (Figure 3B); paratypes, USNM 860756.

Remarks: ***Colligyrus depressus*** is thus far known only from the type locality in southeast Oregon (Figure 5). This species differs from *C. greggi* in its broader shell, absence or vestigial nature of ctenidium, more distal position of penial lobe, longer bursal duct, discoidal shape of the anterior seminal receptacle, division of capsule gland into two distinct units, and slitlike female genital aperture.

Material examined: OREGON. *Harney County:* springs, Cricket Creek, Silvies River drainage, USNM 860756, USNM 883876.

Fluminicola Carpenter, 1864

Type species: *Paludina nuttalliana* Lea, 1838; original designation.

Diagnosis: A morphologically diverse group of northwestern North American lithoglyphine snails.

Remarks: *Fluminicola* and its species recently were reviewed by Hershler & Frest (1996). This genus, as currently constituted, is paraphyletic (Hershler & Frest, 1996:fig. 3), but a confident resolution of its systematics must await a more complete study of the type species, for which anatomical material is not available and which may now be extinct owing to urban development along the lower reach of the Willamette River (type locality area).

Fluminicola coloradensis Morrison, 1940

(Figures 7, 8A–C)

Fluminicola fusca (Haldeman, 1841), Binney, 1865:92 (in part).—Call, 1884:21 (in part).—Pilsbry, 1899:123 (in part).—Hannibal, 1912:187 (in part).—Henderson, 1924:192 (in part).—Chamberlin & Jones, 1929:180–181, fig. 84 (in part; numerous Utah localities).—Henderson, 1936:139.—Jones, 1940:41 (in part).—Baily & Baily, 1951:50 (in part).—*Fluminicola seminalis* (Hinds, 1842), Chamberlin & Jones, 1929:179–180 (in part).

Fluminicola coloradoense Morrison, 1940:125.—Hershler & Frest, 1996:8–9, figs. 1A–F, 2, 4A, 5A–D, 6A, 7A, 8A–C, 9A, 10A, 11.

Lithoglyphus hindsi (Baird, 1863), Taylor, 1966a:fig. 14 (in part).—Taylor, 1985:306 (Green River).—Taylor & Bright, 1987:249 (in part).

Fluminicola hindsi (Baird, 1863), Burch & Tottenham, 1980:102 (in part).

Diagnosis: Large, with subglobose to broadly conical shell. Female bursa copulatrix pyriform, with medium length duct.

Type locality: Green River, Wyoming (not subsequently restricted). Holotype, USNM 526631.

Remarks: *Fluminicola coloradensis* is the large, globose-shelled species with a prominent adapical shoulder and thickened lip that lives in large springs and streams in the Green River and Bonneville basins. This snail was typically referred to as *F. fusca* or *F. hindsi* in the early literature, but in a recent review of the genus (Hershler & Frest, 1996), *F. coloradensis* was shown to be distinct from *F. fuscus* (junior synonym, *Amnicola hindsi* Baird, 1863), which lives in the lower Snake River and Columbia River basins. Hershler & Frest (1996) conservatively attributed *F. coloradensis* solely to the Green River basin, but additional study has shown that Bonneville basin material conforms to this species (e.g., Figure 8A, B) as earlier suggested by Morrison (1940:125). Variation among populations of *F. coloradensis* generally is minor, involving slight differences in shell shape, development of an adapical shoulder on teleoconch whorls, thickness of the inner lip, and penis size. Although a few populations closely similar to *F. coloradensis* are found in the middle portion of the Snake River basin (e.g., Little Wood River), confident confirmation of conspecificity of these with *F. coloradensis* is beyond the scope of this study. Material from springs in Malad Valley (in the northeast segment of the Bonneville basin), and adjacent portions of the Snake River basin (Arbon Valley, Portneuf River drainage) have a distinctively purple shell, and a higher spire and thinner lip than in characteristic *F. coloradensis* (Figure 8C). Anatomically this snail is entirely consistent with *F. coloradensis,* and historical samples of shells from the Malad River also closely conform to typical *F. coloradensis.* Although I treat the Malad Valley material herein as *F. coloradensis,* this problem merits further study. Chamberlin & Jones (1929) suggested that a second species of *Fluminicola* (identified by them as *F. seminalis*) lives in Utah, but material that I have seen from the localities that they referenced (Utah Lake, Tooele Valley) conforms to *F. coloradensis.*

Material examined: IDAHO. *Bear Lake County:* Bear Lake, Fish Haven, USNM 715883 (subfossil).—*Caribou County:* Bear River, Soda Springs, USNM 526730.—Kackley Spring, Gem Valley, T. 10 S, R. 40 E, SW ¼ section 21, USNM 883540, USNM 883700, USNM 883890.—spring, southeast of Kackley Spring, Gem Valley, T. 10 S, R. 40 E, NW ¼ section 27, USNM 883698. *Oneida County:* Big Malad Spring, USNM 883479, USNM 883892.—Little Malad Spring, Malad Valley, T. 12 S, R. 34 E, SW ¼ section 14, USNM 883391, USNM

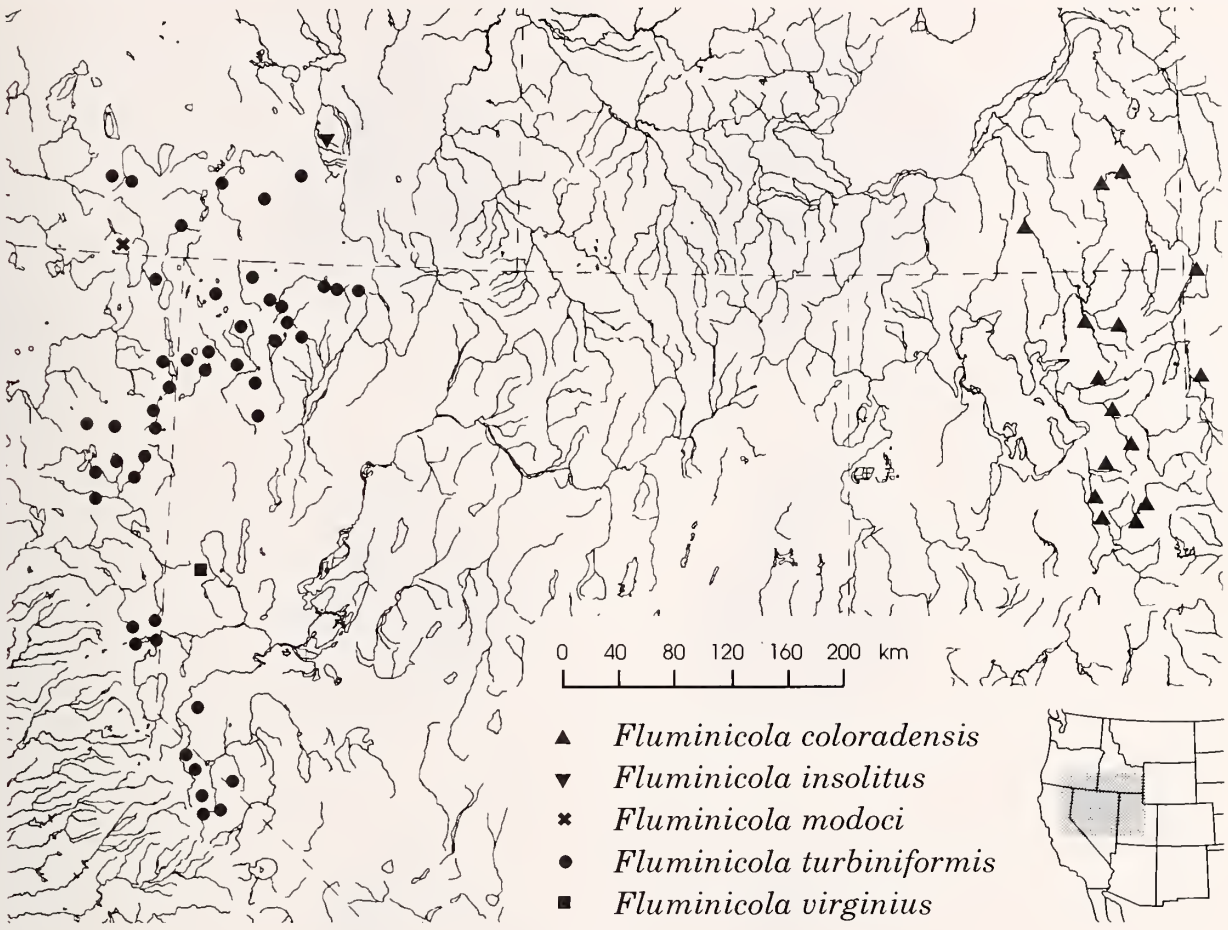
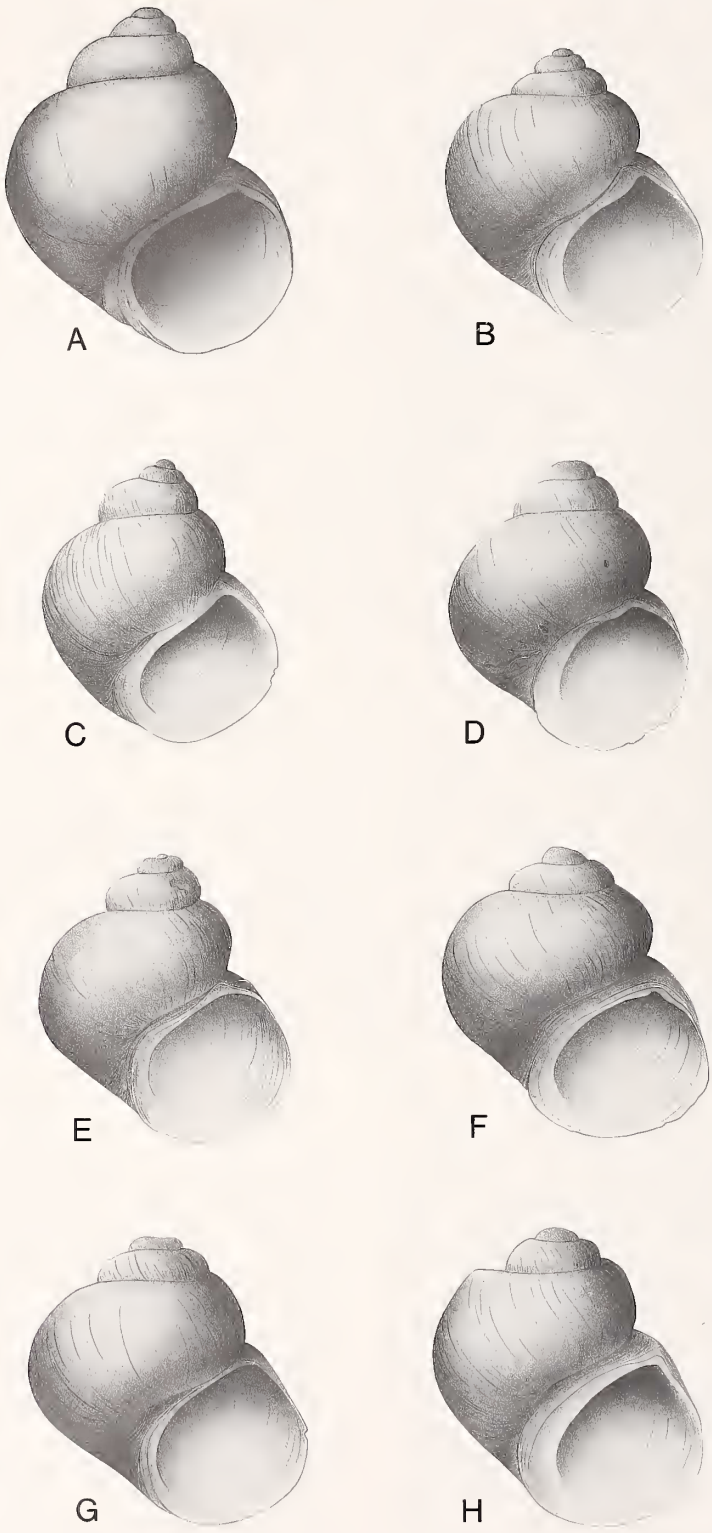


Figure 7

Map of northern Great Basin and adjacent regions showing the distribution of *Fluminicola* species. The type locality of *F. modoci* and previously reported localities for *F. coloradensis* in the Green River drainage (see Hershler & Frest, 1996) are not shown.

883887. **UTAH.** *Elder County:* Malad River, ANSP 62606, FMNH 224425, USNM 47873. *Cache County:* Blacksmith Fork, below Ballard Springs, Cache Valley, FMNH 178420.—Blacksmith Fork, Cache Valley, T. 10 N, R. 2 E, NE ¼ section 9, USNM 883855, USNM 883861.—Murray Spring, Cache Valley, T. 10 N, R. 1 W, SE ¼ section 9, USNM 883475, USNM 883863. *Morgan County:* East Canyon Creek, Weber River drainage, T. 2 N, R. 3 E, NW ¼ section 35, USNM 883854, USNM 883858.—Weber River, HWY 84, south of Peterson, T. 4 N, R. 2 E, NE ¼ section 6, USNM 874068, USNM 883280, USNM 883862. *Rich County:* Bear Lake, west shore, FMNH 179555.—Bear Lake, FMNH 178364.—Bear Lake, east shore, FMNH 178365. *Salt Lake County:* Salt Lake City, USNM 519988.—spring, south of Riverton, Jordan River drainage, T. 4 S, R. 1 W, NW ¼ section 5, USNM 883241, USNM 883286, USNM 883859. *Tooele County:* Tooele Valley, FMNH 178414.—Cottonwood Creek, Holladay, Jordan River drainage, FMNH 178361. *Utah County:* Spring Creek, Utah Lake drainage, T. 5 S, R. 1 E, SW ¼ section 15, USNM 883242, USNM 883860.—Utah Lake, ANSP 27772, ANSP 365332, FMNH 224328, FMNH 224330, USNM 9222, USNM 75452, USNM 31270.—Utah Lake, west shore, FMNH 178857.—Utah Lake, near Saratoga, FMNH 178394, FMNH 179556.—Provo Canyon, above Vivian Park, Utah Lake drainage, FMNH 178355, FMNH 178367. *Wasatch County:* Provo River, below Charleston, FMNH 179221, FMNH 179222. *Weber County:* 0.8 km below Ogden Canyon, FMNH 178391.—just outside Ogden Canyon, Ogden, ANSP 144614.—entrance to Ogden Canyon, Ogden, ANSP 145845.—Ogden River, FMNH 178396. **WYOMING.** Green River, USNM 526631. *Lincoln County:* Smiths Fork, Bear River drainage, T. 24 N, R. 119 W, NE ¼ section 5, USNM 883902. *Uinta County:* Bear River, HWY 89, northwest of Evanston, T. 16 N, R.


A
B
C
D
E
F
G
H

121 W, NW ¼ section 13, USNM 883525, USNM 883864, USNM 883865.

Fluminicola ***insolitus,*** Hershler, sp. nov.

Donner und Blitzen pebblesnail

(Figures 7, 8D, 9, 10A–C)

Lithoglyphus turbiniformis (Tryon, 1865), Taylor, 1966a, fig. 9 (in part).—Taylor, 1985:309 (in part; "headwaters of the Donner und Blitzen River").

Etymology: From New Latin *insolitus,* meaning unusual or uncommon, and referring to the divergent aspect of this species.

Diagnosis: Medium-sized with trochoidal shell. Female bursa copulatrix ovate, with medium length duct.

Description: Shell (Figure 9A) trochoidal, rarely with eroded spire; height, 3.6–4.2 mm; whorls, 3.75–4.0. Protoconch (Figure 9B) of 1.5 whorls, diameter about 0.76 mm; microsculpture of numerous weak spiral striae. Teleoconch whorls convex, usually evenly rounded, rarely shouldered. Microsculpture of well-developed collabral growth lines and weak, often eroded, spiral striae. Periostracum olive. Shell opaque, dark gray or purple. Aperture large, lunate, weakly angled adapially. Outer lip prosocline, thin. Parietal lip thin, complete across body whorl, adnate. Columellar swelling broad, covering near entirety of umbilical region. Shell usually anomphalous, rarely narrowly umbilicate.

Operculum (Figure 9C, D) thin, light amber, ovate, paucispiral; outer margin without rim. Attachment scar margin slightly thickened all around. Callus weakly developed.

Radula with about 80 rows of teeth; ribbon length, 2.4 mm, ribbon width, 160 μm; central tooth width, 62 μm. Cutting edge of central tooth (Figure 9E, F) weakly indented; lateral cusps, 3–6; median cusp narrow U-shaped, slightly broader and longer than laterals; basal cusps absent; basal tongue broad, extending below lateral margins, basal sockets weakly excavated. Lateral margins angled about 50° relative to vertical axis of teeth; margins narrow, thin. Lateral tooth (Figure 9G) with slightly convex cutting edge. Lateral wing 60% of length of cutting edge; tooth face broader than tall; central cusp U-shaped, lateral cusps, 3–5 (inner), 4–6 (outer). Inner marginal teeth (Figure 9H) with 16–19 cusps; outer marginal teeth (Figure 9I) with13–23 cusps. Cusps on inner marginal teeth larger than those on outer marginals. Salivary glands long, unpigmented. Stomach longer than style sac.

Snout, tentacles, foot dark brown or black. Bases of tentacles around eyes sometimes pale. Neck light gray. Pallial roof and visceral coil dark brown or black, pigment somewhat lighter on gonads and genital ducts; pallial edge black.

Ctenidium positioned slightly anterior to pericardium; filaments about 21, small, taller than wide, without pleats. Osphradium about 33% of ctenidium length. Hypobranchial gland without anterior swelling. Renal organ with prominent (45%) pallial portion; renal opening simple. Cephalo-pedal ganglia weakly pigmented.

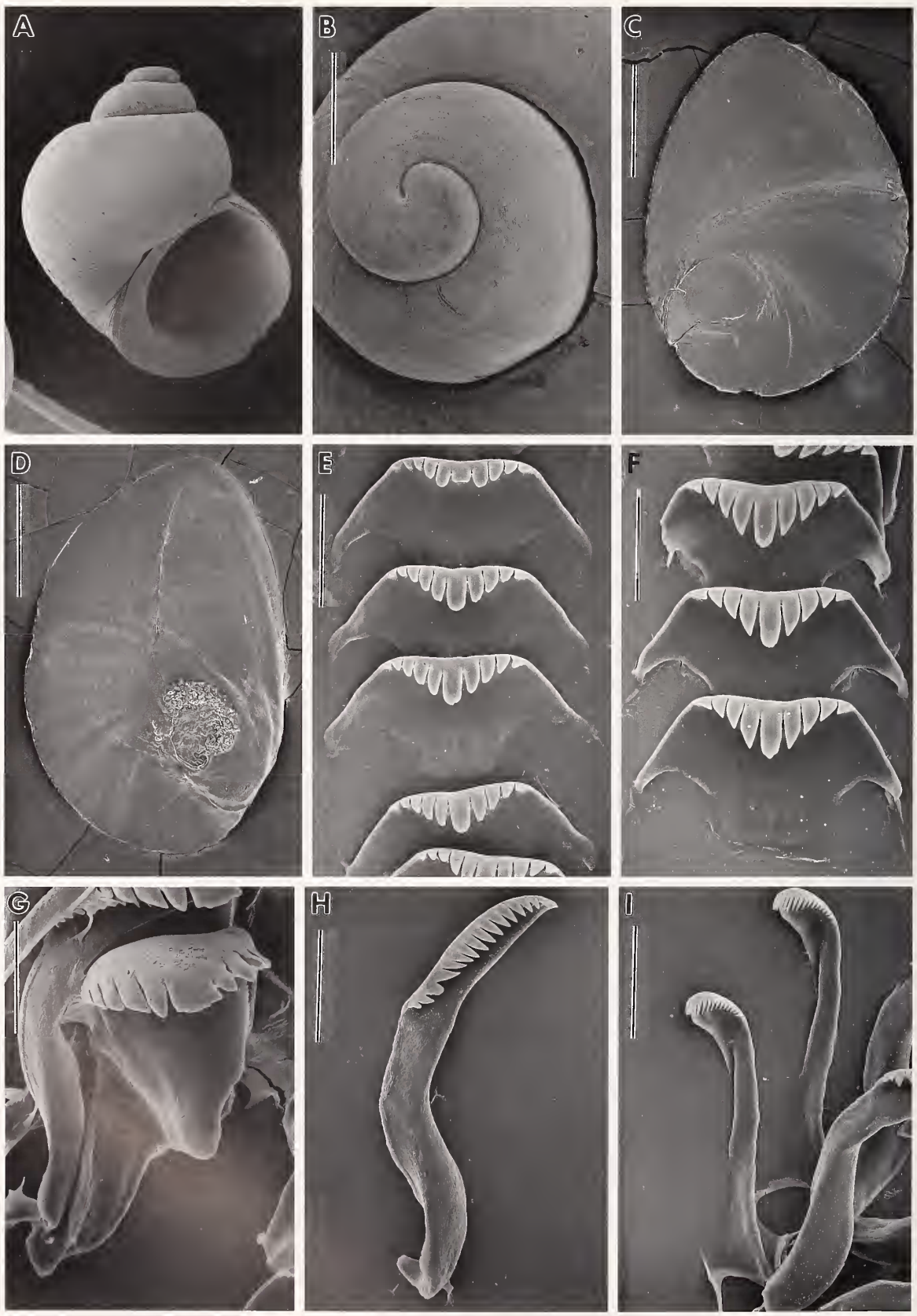
Ovary 0.25–0.5 whorl, abutting or slightly posterior to edge of stomach, filling less than 50% of digestive gland behind stomach. Distal female genitalia shown in Figure 10A, B. Coiled oviduct posterior-oblique; proximal arm strongly kinked or with small coil; distal arm swollen with sperm. Coiled oviduct and bursal duct join just behind pallial wall (slightly behind posterior edge of capsule gland). Bursa copulatrix about 60% of albumen gland length; ovate, transversely oriented, about 50% overlapped by albumen gland. Bursal duct medium length (ca. 50% of bursa length), narrow, originating near ventral edge of bursa copulatrix. Seminal receptacle much smaller than bursa copulatrix, positioned just anterior to bursa copulatrix along posterior edge of albumen gland, completely overlapped by albumen gland. Albumen gland with deep rectal furrow; furrow weakly developed on capsule gland. Albumen gland without pallial component; capsule gland with short visceral section. Capsule gland about as long as, but narrow than albumen gland; capsule gland folded over to the right. Ventral channel without anterior vestibule. Genital opening a small terminal slit.

Testis 1.0–1.25 whorl, overlapping posterior stomach chamber, filling more than 50% of digestive gland length behind stomach. Prostate gland with 33% of length in pallial roof. Pallial vas deferens with weak proximal kink; portion of vas deferens in neck straight. Penis (Figure 10C) medium to large, broad sickle shape, curved, without folds; base sometimes slightly narrowed, medial section without taper; distal section rounded, with short, narrow papillalike tip. Penial duct near central, undulating throughout (more pronounced distally). Penis pale or with light dusting of melanin proximally.

←

Figure 8

Type and other shell material for Great Basin species of *Fluminicola.* A. *F. coloradensis,* ANSP 27772 (shell height 8.1 mm). B. *F. coloradensis,* USNM 883280 (8.5 mm). C. *F. coloradensis,* USNM 883479 (8.5 mm). D. *F.* ***insolitus*** Hershler, sp. nov., holotype, USNM 883466 (3.7 mm). E. *F. turbiniformis,* USNM 858249 (4.8 mm). F. *F. turbiniformis,* USNM 883527 (2.0 mm). G. *F. turbiniformis,* USNM 858241 (3.2 mm). H. *F.* ***virginius*** Hershler, sp. nov., holotype, USNM 874902 (2.7 mm).


A
B
C
D
E
F
G
H
I

Type locality: Page Springs, Donner und Blitzen River drainage, Harney County, Oregon, T. 32 S, R. 32½ E, NW ¼ section 17. A small rheocrene (11°C, 89 micromhos/cm) draining west to the Donner und Blitzen River (Figure 4C). This site did not appear disturbed when visited in 1993. Holotype, USNM 883466 (Figure 8D), collected by D. W. Sada, 8 July 1993; paratypes, USNM 860757.

Remarks: This snail, endemic to the type locality (Figure 7), is unique in the genus in having a very broad basal process of the central radular teeth and lacking basal cusps on these teeth. *Fluminicola* ***insolitus*** most closely resembles *F. turbiniformis,* which also lives in the northwest Great Basin (see below) and with which it was previously confused (Taylor, 1966a, 1985), but further differs from this species in the purple tint of its shell, thinner shell parietal lip, stouter lateral radular teeth, and stouter bursa copulatrix with longer duct.

Material examined: OREGON. *Harney County:* Page Springs, Donner und Blitzen River drainage, USNM 860757, USNM 883192, USNM 883466.

Fluminicola modoci Hannibal, 1912

(Figure 7)

Fluminicola modoci Hannibal, 1912:187, pl. 8: fig. 30.—Turgeon et al., 1988:60.—Hershler & Frest, 1996:13–14, figs. 4F, 5H–J, 6E, 7D, 8J–L, 9D, 10D, 11.

Lithoglyphus modoci (Hannibal, 1912), Taylor, 1975:125 (literature compilation).

Diagnosis: Small with broadly conical shell. Female bursa copulatrix sub-globose, with short duct.

Type locality: Fletchers Spring, south end, Goose Lake, California. Lectotype, CAS 60798.

Remarks: Hershler & Frest (1996) discussed problems with the types and identity of this species. Dry Creek discharges into the northwestern side of Goose Lake (Figure 7) about 32 km north of the type locality area. Snails from the Dry Creek spring have broad, typically decollate shells closely conforming to *F. modoci.*

Material examined: CALIFORNIA. *Modoc County:* Fletchers Spring, south end, Goose Lake, CAS 60798. **OREGON.** *Lake County:* spring, source of Dry Creek, Goose Lake basin, T. 40 S, R. 17 E, SE ¼ section 36, USNM 883554, USNM 883558.

Fluminicola turbiniformis (Tryon, 1865)

(Figures 7, 8E–G)

Amnicola turbiniformis Tryon, 1865:219, pl. 22: fig. 5.

Fluminicola turbiniformis (Tryon, 1865), Baker, 1964:177.—Turgeon et al., 1988:61.—Hershler & Frest, 1996:16–17, figs. 5K, L, 6H, 9F, 13D, 14, 16B, 17D–F, 18B.

Lithoglyphus turbiniformis (Tryon, 1865), Taylor, 1966a:24, fig. 9 (in part).—Taylor, 1975:197 (in part; literature compilation).—Taylor, 1985:309 (in part).

Diagnosis: Small with ovate to narrow-conic shell. Female bursa copulatrix ovate, with short duct.

Type locality: west side of Steens Mountain, Catlow Valley, Oregon. The type locality has not been precisely located. Lectotype, ANSP 27779.

Remarks: This species ranges widely throughout the northwest Great Basin, from Lake Abert basin east to Quinn River basin and south to Walker River basin (Figure 7). This range conforms in part to that depicted by Taylor (1966a:fig. 9), although populations in the Donner und Blizten River drainage and the eastern side of the Pyramid Lake basin are herein described as new species, and I do not recognize *F. turbiniformis* in the Sacramento and Columbia River basins. I am also unable to confirm presence of *F. turbiniformis* in the Deschutes River drainage as reported by Taylor (1985:309). Populations of *F. turbiniformis* vary in size, relative shell height, width of columellar lip, and excavation of umbilical region (Figure 8E–G); and also in size of penis relative to head. Several populations in the Smoke Creek Desert and Honey Lake basin in northeast California are distinguished by their especially large size, rather globose, frequently decollate shell with thin shell lip (Figure 8G), but intergradation with more typical *F. turbiniformis* is apparent.

Material examined: CALIFORNIA. *Alpine County:* spring, Monitor Creek, Carson River basin, T. 9 N, R. 21 E, section 3, USNM 854752.—springs, northeast side of Bagley Valley, Carson River basin, T. 9 N, R. 21 E, NE ¼ section 15, USNM 858240. *Lassen County:* spring, Old Marr Ranch, Duck Flat, T. 37 N, R. 17 E, NE ¼ section 31, USNM 858252.—springs, west of Dairy Spring, Grasshopper Valley, T. 34 N, R. 11 E, SW ¼ section 4, USNM 858248.—spring, Painters Creek, Madeline Plains, T. 34 N, R. 17 E, NW ¼ section 30, USNM 858250.—springs, Cold Spring Valley, Madeline Plains,

←

Figure 9

Scanning electron micrographs of shell, operculum, and radula of *Fluminicola* ***insolitus*** Hershler, sp. nov., USNM 860757. A. Shell (height 3.5 mm). B. Shell apex. Bar = 300 μm. C. Operculum, outer surface. Bar = 428 μm. D. Operculum, inner surface. Bar = 444 μm. E, F. Central radular teeth. Bars = 26 μm. G. Lateral radular tooth. Bar = 20.5 μm. H. Inner marginal tooth. Bar = 23 μm. I. Outer marginal teeth. Bar = 26 μm.

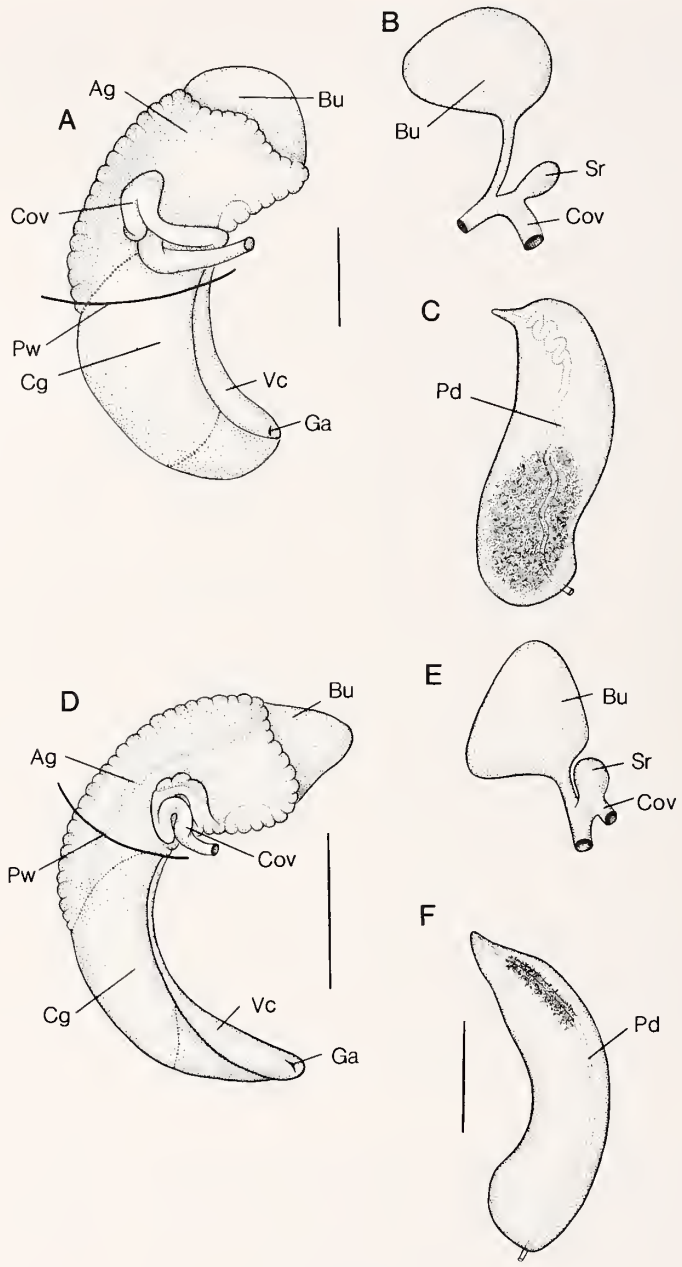


Figure 10

Genitalia of *Fluminicola* species (A–C, *F. **insolitus*** Hershler, sp. nov., USNM 860757; D–F, *F. **virginius*** Hershler, sp. nov., USNM 874103). A. Left side of female glandular oviduct and associated structures. Bar = 0.5 mm. B. Bursa copulatrix and seminal receptacle. Scale as in "A." C. Dorsal surface of penis. Scale as in "A." D. Left side of female glandular oviduct and associated structures. Bar = 0.5 mm. E. Bursa copulatrix and seminal receptacle. Scale as in "D." F. Dorsal surface of penis. Bar = 0.25 mm. Ag, albumen gland; Bu, bursa copulatrix; Cg, capsule gland; Cov, coiled oviduct; Ga, genital aperture; Pd, penial duct; Pw, posterior wall of pallial cavity; Sr, seminal receptacle; Vc, ventral channel of capsule gland.

T. 36 N, R. 16 E, SW ¼ section 18, USNM 858251.—Bailey Creek, Madeline Plains, T. 34 N, R. 12 E, NE ¼ section 15, USNM 858249.—spring, south of HWY 36 ca. 4.8 km west of Susanville, Susan River basin, T. 30 N, R. 11 E, SW ¼ section 35, USNM 858244.—Five Springs, Honey Lake basin, T. 31 N, R. 16 E, NE ¼ section 23, USNM 858247.—spring, Willow Creek, Willow Creek Valley, T. 32 N, R. 11 E, SE ¼ section 35, USNM 874933.—Shoals Creek, Horse Lake basin, T. 32 N, R. 13 E, NW ¼ section 6, USNM 858245, USNM 858246.—Tule Patch Spring, Honey Lake basin, T. 32 N, R. 15 E, SE ¼ section 10, USNM 854468, USNM 858256, USNM 873394.—spring, east of Sage Hen Spring, Smoke Creek, T. 33 N, R. 16 E, SW ¼ section 25, USNM 874054.—springs, Shinn Ranch, Smoke Creek, T. 33 N, R. 16 E, SW ¼ section 36, USNM 858257, USNM 874100.—Big Spring, Smoke Creek, T. 33 N, R. 16 E, NW ¼ section 3, USNM 858260, USNM 858338.—spring, southwest of Sage Hen Spring, Smoke Creek, T. 33 N, R. 16 E, NE ¼ section 35, USNM 858258.—Sage Hen Spring, Smoke Creek, T. 33 N, R. 16 E, NE ¼ section 35, USNM 858259. *Modoc County:* springs, 1.1 km north of Fandanga Pass turnoff, Surprise Valley, T. 46 N, R. 16 E, NE ¼ section 31, USNM 858255.—Von Riper Spring, Surprise Valley, T. 39 N, R. 16 E, NW ¼ section 25, USNM 858253.—spring, southwest of Von Riper Spring, Surprise Valley, T. 39 N, R. 16 E, NW ¼ section 36, USNM 858254. *Mono County:* spring, Silver Creek, Pickel Meadow, West Walker River basin, T. 6 N, R. 22 E, NW ¼ section 24, USNM 873406.—springs, east side West Walker River, T. 6 N, R. 23 E, NE ¼ section 9, USNM 873361.—springs, west side Little Walker River, T. 6 N, R. 23 E, SW ¼ section 15, USNM 873412.—springs, southeast corner Slinkard Valley, West Walker River basin, T. 8 N, R. 22 E, SW ¼ section 15, USNM 873346. *Nevada County:* spring, Sagehen Creek, Little Truckee River basin, T. 18 N, R. 15 E, section 1, USNM 892040.—spring, Sagehen Creek, Little Truckee River basin, T. 18 N, R. 15 E, section 3, USNM 892042.—spring, Sagehen Creek, Little Truckee River basin, T. 18 N, R. 16 E, section 6, USNM 892041.—Boca Spring, Truckee River basin, T. 18 N, R. 17 E, NE ¼ section 10, USNM 858242. *Sierra County:* spring, east side HWY 89, south of Kyburz Flat, Little Truckee River basin, T. 19 N, R. 16 E, NW ¼ section 29, USNM 858241.—spring, Hoke Valley, Little Truckee River basin, T. 19 N, R. 17 E, SW ¼ section 2, USNM 858243, USNM 858357. NEVADA. *Humboldt County:* North Hell Creek Spring, Virgin Valley, T. 44 N, R. 24 E, NW ¼ section 3, USNM 873213, USNM 873226, USNM 874218.—Boulder Spring, Virgin Valley, T. 44 N, R. 25 E, SW ¼ section 19, USNM 874049.—The Dip (spring), Hell Creek, Virgin Valley, T. 44 N, R. 24 E, SW ¼ section 9, USNM 873207.—spring, Cherry Gulch, Bog Hot Valley, T. 45 N, R. 29 E, SW ¼ section 8, USNM 883933.—spring, Fivemile Flat, Summit Lake basin, T. 43 N, R. 25 E, SE ¼ section 35, USNM 892030.—spring, Antelope Creek, T. 46 N, R. 30 E, NW ¼ section 28, USNM 874212.—Antelope Springs, Soldier Meadow, T. 41 N, R. 25 E, NW ¼ section 32, USNM 883526.—spring, Bartlett Creek, Black Rock Desert, T. 41 N, R. 27 E, SE ¼ section 5, USNM 883901.—spring, Virgin Creek, Quinn River Valley, T. 46 N, R. 30 E, NE ¼ section 34, USNM 874213, USNM 874738. *Lyon County:* spring, upper Illinois Canyon, Carson River basin, T. 14 N, R. 22 E, SE ¼ section 7, USNM 874903, USNM 883527.—spring, Sweetwater Mountains, West Walker River basin, T. 8 N, R. 24 E, SE ¼ section 27, USNM 854627 (southern spring), USNM 854628 (middle spring). *Washoe County:* spring, South Catnip Creek, Guano Valley, T. 46 N, R. 22 E, NE ¼ section 24, USNM 874206.—spring, Wall Creek, 4.8 km above reservoir, Duck Flat, T. 38 N, R. 20 E, NE ¼ section 6, USNM 854706.—spring, northeast of Middle Lake, Long Valley, T. 46 N, R. 21 E, center section 30, USNM 854753.—spring, near southeast corner of Boulder Reservoir, Boulder Flat, T. 40 N, R. 20 E, NE ¼ section 32, USNM 874186.—spring, east side of Hays Canyon Range, Boulder Flat, T. 40 N, R. 19 E, SW ¼ section 32, USNM 874266.—spring, south of Garden Lake, Duck Flat, T. 35 N, R. 18 E, SW ¼ section 12, USNM 883927.—Clear Creek, Granite Mountain, Black Rock Desert, T. 34 N, R. 22 E, NE ¼ section 26, USNM 874290.—Clear Creek, Granite Mountain, T. 34 N, R. 22 E, section 26, USNM 854066.—spring (west of road), Bog Hog Ranch Creek, High Rock basin, T. 38 N, R. 23 E, NE ¼ section 19, USNM 874209.—spring (east of road), Bog Hog Ranch Creek, High Rock basin, T. 38 N, R. 23 E, NW ¼ section 20, USNM 874199.—spring, 3.2 km north-northwest of Little High Rock Reservoir, High Rock basin, T. 39 N, R. 23 E, NW ¼ section 30, USNM 874219.—Cottonwood Spring, High Rock basin, T. 43 N, R. 24 E, SE ¼ section 30, USNM 874215. OREGON. *Harney County:* west side of Steens Mountains, ANSP 27779.—Roaring Springs, Catlow Valley, T. 33 S, R. 30 E, NE ¼ section 31, USNM 883470.—Willow Spring, Catlow Valley, T. 36 S, R. 29 E, NW ¼ section 30, USNM 892029. *Lake County:* spring near source of Guano Creek, Guano Valley, USNM 883560.—spring, Dairy Creek, Chewaucan River drainage, T. 36 S, R. 17 E, SE ¼ section 12, USNM 883565.—spring, Dairy Creek, Chewaucan River drainage, T. 36 S, R. 17 E, SE ¼ section 11, USNM 883553.—Moss Spring, Lake Abert basin, T. 36 S, R. 19 E, SE ¼ section 5, USNM 883882.—springs, Deep Creek Falls, Warner Valley, T. 39 S, R. 23 E, NE ¼ section 23, USNM 883552.

Fluminicola ***virginius*** Hershler, sp. nov.

Virginia Mountains pebblesnail

(Figures 7, 8H, 10D–F, 11)

Lithoglyphus turbiniformis (Tryon, 1865), Taylor, 1966a, fig. 9 (in part).

Etymology: Referring to endemism of this snail in the Virginia Mountains west of Pyramid Lake.

Diagnosis: Medium-sized with trochoidal to low conic shell. Female bursa copulatrix ovate-pyriform, with short duct.

Description: Shell (Figure 11A) trochoidal to low conic, rarely with eroded spire; height, 2.9–3.4 mm; whorls, 3.25–3.75. Protoconch (Figure 11B, C) of 1.7 whorls, diameter about 0.50 mm; microsculpture of numerous spiral striae, often stronger close to periphery. Teleoconch whorls convex, often having peripheral angulation; shoulder well developed, often forming pronounced, rounded keel. Aperture and last 0.25–0.50 whorl disjunct. Microsculpture of well-developed collabral growth lines. Periostracum tan. Shell clear, translucent. Aperture large, ovate, angled above. Outer lip weakly prosocline, somewhat thickened. Parietal lip complete across body whorl, disjunct, thick. Columellar swelling broad; columellar lip thick. Shell anomphalous or narrowly umbilicate.

Operculum (Figure 11D, E) thin, light amber, ellipsoidal, paucispiral, nucleus highly eccentric; outer margin without rim. Attachment scar margin slightly thickened along inner edge. Callus weakly developed.

Radula with about 85 rows of teeth; ribbon length, 885 μm; ribbon width, 115 μm; central tooth width, 28 μm. Cutting edge of central tooth (Figure 11F) weakly indented; lateral cusps, 4–6; median cusp narrow U-shaped, pointed, slightly broader and longer than laterals; basal cusps, 1–2, cusp on outer side smaller; basal tongue V-shaped, even with lateral margins; basal sockets moderately excavated; lateral margins narrow, slightly thickened, angled about 55° to vertical axis of tooth. Cutting edge of lateral tooth (Figure 11G) horizontal or with weakly indented; cutting edge about 67% of length of lateral wing; tooth face taller than broad; central cusp rounded, narrow U-shaped, lateral cusps, 2–4 (inner), 3–5 (outer). Inner marginal teeth (Figure 11H) with 28–36 cusps; outer marginal teeth (Figure 11I) with 25–30 cusps. Cusps on inner marginal teeth larger than those on outer marginals. Stomach longer than style sac.

Snout light gray to black. Tentacles light gray to black, pigment often lighter around eyes. Foot light to medium gray. Opercular lobe black along inner edge. Pallial roof, visceral coil black.

Ctenidium positioned slightly anterior to pericardium; filaments about 14, small, about as tall as wide, without pleats. Osphradium about 38% of ctenidium length. Hypobranchial gland without anterior swelling. Renal organ with prominent (50%) pallial portion; renal opening slightly thickened. Cephalo-pedal ganglia pigmented.

Ovary 0.25–0.4 whorl, abutting or slightly overlapping edge of stomach, filling less than 50% of digestive gland behind stomach. Distal female genitalia shown in Figure 10D, E. Primary loop of coiled oviduct narrowly vertical to circular; distal arm swollen with sperm. Primary loop preceded by smaller, narrowly vertical loop. Oviduct and bursal duct join behind pallial wall (slightly behind posterior edge of capsule gland). Bursa copulatrix about 55% of albumen gland length; ovate to pyriform, transversely oriented, about 50% overlapped by albumen gland. Bursal duct short (ca. 25–40% of bursa length), narrow, originating near ventral edge of bursa. Seminal receptacle smaller (33%) than bursa copulatrix, positioned slightly anterior or slightly overlapping bursa copulatrix near ventral edge of albumen gland, usually completely overlapped by albumen gland. Albumen gland with well-developed rectal furrow. Albumen gland with moderate (40%) pallial component; capsule gland entirely pallial. Capsule gland about as long, but narrower than albumen gland; capsule gland folded over to the right. Ventral channel without anterior vestibule. Genital opening a small terminal slit.

Testis 1.0 whorl, overlapping posterior stomach chamber, filling about 50% of digestive gland behind stomach. Prostate gland with 33% of length in pallial roof. Pallial vas deferens very narrow, straight; portion of vas deferens in neck straight. Penis (Figure 10F) medium-sized, sickle-shaped, weakly curved, without folds; base sometimes slightly narrowed, medium section without taper; distal section sharply pointed. Penial duct near outer edge, straight, surrounded by internal core of melanin distally. External surface of penis pale.

Type locality: Unnamed ("Waterfall") spring, source of Hardscrabble Creek, Pyramid Lake basin, Washoe County, Nevada, T. 24 N, R. 20 E, SE ¼ section 13. A broad (400 m wide), shallow rheocrene (16.1°C, 144 micromhos/cm) (Figure 4D). Holotype, USNM 874902 (Figure 8H), collected by G. Vinyard, 31 October 1992; paratypes, USNM 860758.

Remarks: This species is distinguished from other congeners by the strongly (adapically) angled shell whorls, large shell aperture, and highly eccentric operculum nucleus. *Fluminicola* ***virginius*** otherwise closely resembles *F. turbiniformis,* although it also differs from this species in having a relatively longer bursal duct.

Material examined: NEVADA. *Washoe County:* Unnamed ("Waterfall") spring, source of Hardscrabble Creek, Pyramid Lake basin, USNM 860758, USNM 874105, USNM 874902.

Pristinicola Hershler et al., 1994

Type species: *Bythinella hemphilli* Pilsbry, 1890; original designation.

Diagnosis: A monotypic northwestern United States genus having small to medium-sized, narrow-conic shell with wrinkled protoconch, smooth whorls, and simple aperture. Animal pale. Penis without accessory lobes or glands. Female coiled oviduct of tight loops; glandular

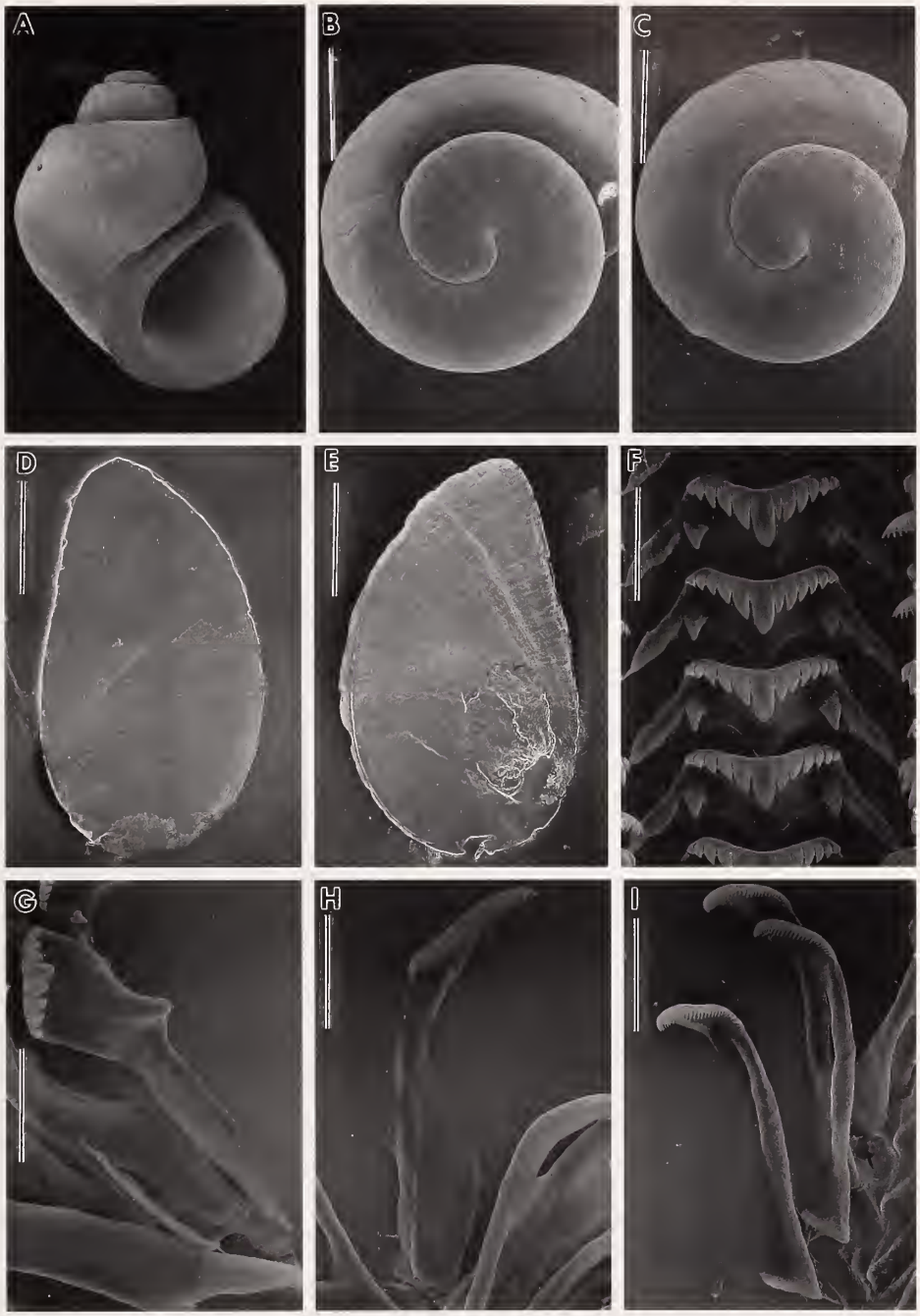


Figure 11

Scanning electron micrographs of shell, operculum, and radula of *Fluminicola* ***virginius*** Hershler, sp. nov. A. Shell, USNM 860758 (height 2.6 mm). B, C. Shell apex, USNM 860758. Bars = 300 μm, 240 μm, respectively. D. Operculum, outer surface, USNM 874105. Bar = 315 μm. E. Operculum, inner surface, USNM 874105. Bar = 300 μm. F. Central radular teeth, USNM 874105. Bar = 12 μm. G. Lateral radular tooth, USNM 874105. Bar = 13.8 μm. H. Inner marginal tooth, USNM 874105. Bar = 14.6 μm. I. Outer marginal teeth, USNM 874105. Bar = 15 μm.

oviduct large, ventrally closed; bursa copulatrix large, posteriorly recurved; seminal receptacle pouchlike.

Remarks: The single species in this genus was recently reviewed by Hershler et al. (1994).

Pristinicola hemphilli (Pilsbry, 1890)

(Figure 5)

Bythinella hemphilli Pilsbry, 1890:63.—Turgeon et al., 1988:60.
Pristinicola hemphilli (Pilsbry, 1890), Hershler et al., 1994: 225–233, figs. 1 (top row), 2–7.

Diagnosis: As for genus.

Type locality: Near Kentucky Ferry, Snake River, Washington. This locality has not been precisely located (Henderson, 1936; Hershler et al., 1994). Lectotype, ANSP 31176.

Remarks: The Great Basin populations closely resemble other material of this species, which previously was known from the lower Snake-Columbia River basin and other Pacific coastal drainages of Washington, with shells 3.0–3.5 mm tall and having about 5.0 whorls. The Great Basin localities (Figure 5) are upland waters which drain south to the Harney-Malheur basin. It is noteworthy that the fish faunas of the Great Basin and Columbia River drainage also overlap considerably in this region (Bisson & Bond, 1971).

Material examined: OREGON. *Harney County:* Mountain Spring, Silvies River drainage, T. 19 S, R. 32 E, SE ¼ section 3, USNM 883878.—Unnamed springs, Cricket Creek, Silvies River drainage, T. 21 S, R. 28 E, NW ¼ section 12, USNM 883875.—Adams Spring, head of Allison Creek, Silver Creek (Harney Lake drainage), T. 19 S, R. 26 E, SW ¼ section 12, USNM 883879. **WASHINGTON.** Near Kentucky Ferry, Snake River, ANSP 31176.

Eremopyrgus, Hershler, gen. nov.

Type species: ***Eremopyrgus eganensis,*** sp. nov.

Etymology: From Greek, *eremos,* away from, separate; and *pyrgos,* tower. Referring to the isolation of this snail in eastern Nevada, and to its elongate shell. Gender masculine.

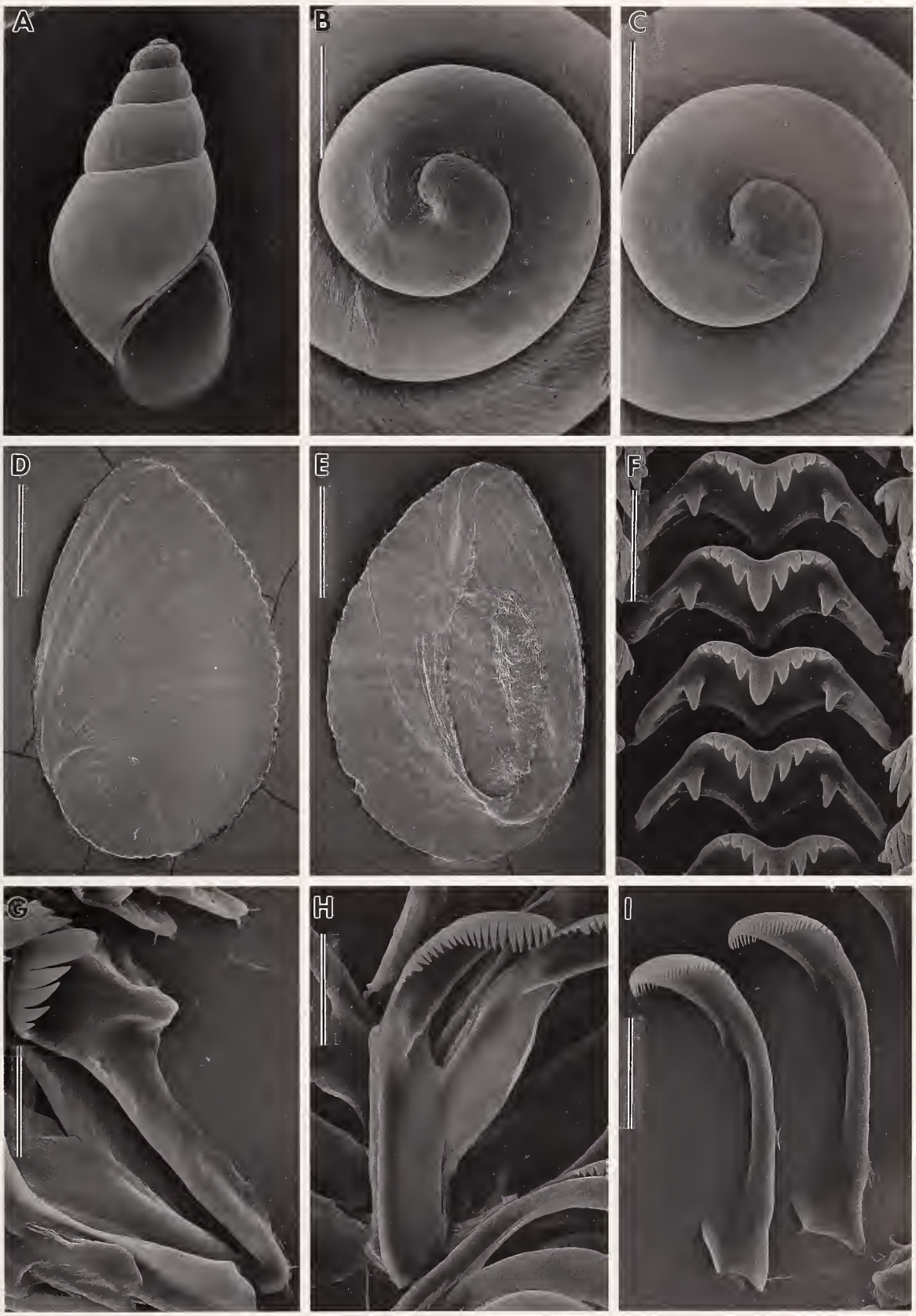
Diagnosis: A Great Basin cochliopine group having medium-sized, conical shell. Penis ornamented with two squat, glandular lobes, positioned along outer edge medially and inner edge distally. Distal portion of penis swollen, pointed, without terminal papilla. Females ovoviviparous; capsule gland thin-walled, functioning as brood pouch; bursa copulatrix large, seminal receptacle minute; fertilization duct coiled, opening to bursa copulatrix.

Description: Shell (Figure 12A) conical, with pronounced spire; height, 3.1–3.8 mm; whorls, 4.5–5.25, teleoconch whorls weakly convex, usually evenly rounded, sometimes having sub-sutural angulation. Shell clear-white, periostracum thin, brown. Protoconch (Figure 12B, C) of 1.60–1.75 whorls, diameter about 0.34 mm; initial portion often sculptured with a few, irregular wrinkles, later portion sometimes having a few weak spiral elements. Protoconch followed by distinct, relatively smooth 0.5 whorl corresponding to shell growth within the female brood pouch. Teleoconch microsculpture of faint growth lines and occasional weak spiral striae. Aperture medium-sized, narrowly ovate, strongly angled adapically; outer lip rarely slightly thickened internally, orthocline or weakly prosocline, sometimes weakly sinuate; parietal lip complete across body whorl, thin, broadly adnate; columellar swelling absent or narrow. Shell anomphalous or rimate. Operculum (Figure 12D, E) medium thickness, amber, ellipsoidal, paucispiral, nucleus highly eccentric; outer margin without rim. Attachment scar margin thickened all around. Callus sometimes well developed. Salivary glands simple, narrow tubes. Radula with about 52 rows of teeth; ribbon length, 557 μm, ribbon width, 90 μm; central tooth width, 22 μm. Central tooth (Figure 12F) with weak dorsal indentation; lateral cusps, 4–5; median cusp pointed, considerably broader and longer than laterals; basal cusp, 1; basal tongue V-shaped, often distinctly separated from remaining base, about even with lateral margins; basal sockets medium indented; lateral margins slightly thickened, inclined about 55° to vertical axis of teeth. Lateral tooth with slightly convex dorsal edge; lateral wings about 150% width of cutting edge; tooth face about as tall as wide; central cusp U-shaped; lateral cusps, 3–4 (inside), 4–5 (outside). Inner marginal teeth with 20–27 cusps; outer marginal teeth with 27–34 cusps. Cusps on inner marginals larger than those on out-

→

Figure 12

Scanning electron micrographs of shell, operculum, and radula of ***Eremopyrgus eganensis*** Hershler, sp. nov. A. Shell, USNM 860759 (height 3.3 mm). B, C. Shell apex, USNM 860759. Bars = 150 μm, 230 μm, respectively. D. Operculum, outer surface, USNM 883940. Bar = 333 μm. E. Operculum, inner surface, USNM 883940. Bar = 315 μm. F. Central radular teeth, USNM 883940. Bar = 10 μm. G. Lateral radular tooth, USNM 883940. Bar = 11 μm. H. Inner marginal tooth, USNM 883940. Bar = 11 μm. I. Outer marginal teeth, USNM 883940. Bar = 12 μm.


A
B
C
D
E
F
G
H
I

er marginals. Dorsal folds of esophagus long, straight. Cephalic tentacles medium length in preserved material. Tentacles pale or pigmented with scattered gray granules, sometimes forming longitudinal strip. Snout, foot pale or light to medium gray-brown. Opercular lobe sometimes black along inner edge. Neck pale or pigmented with scattered gray-brown granules. Pallial roof, visceral coil variably pigmented, usually light to medium brown, sometimes black. Ctenidium abutting pericardium; filaments about 22, well developed, slightly taller than wide, without pleats. Osphradium small (15%), centrally positioned. Hypobranchial gland well developed along rectum. Renal organ with large (50%) pallial portion; renal opening simple. Salivary glands small, tubular. Stomach longer than style sac, without posterior caecum. Cephalopedal ganglia strongly pigmented; cerebral, pedal commissures relatively long (ca. 50%). Oviduct terminating as narrow, blind tube just behind stomach. Distal female genitalia shown in Figure 13A, B. Coiled oviduct of a single, small posterior-oblique loop. Seminal receptacle a minute sac positioned along left side of bursa copulatrix near ventral edge. Seminal receptacle duct very short, opening to oviduct along ventral edge of bursa copulatrix just distal (and anterior) to oviduct coil (slightly behind the pallial wall) where also joined by the albumen gland and the narrow, coiled fertilization duct. Fertilization duct opening to left side of bursa copulatrix near anterior edge; duct having several tight coils on right side of bursa copulatrix before looping ventrally onto left side, where it coils once more before joining the oviduct. Bursa copulatrix relatively large, saclike, positioned along the left-ventral side of the brood pouch, extending to near the posterior edge of the brood pouch; duct short, narrow; sperm tube opening to pallial cavity a little anterior to pallial wall. Brood pouch large, posteriorly folded (and greatly narrowed) along right side of bursa copulatrix. Pouch containing relatively few (2–5) embryos having up to 2.5 whorls. Albumen gland very short, narrow, positioned along right edge of bursa copulatrix. Genital aperture a slightly muscularized terminal slit. Testis 1.0 whorl, overlapping posterior stomach chamber, filling about 50% of digestive gland behind stomach. Prostate gland strongly recurved, with about 50% of length in pallial roof. Anterior vas deferens exiting prostate gland a little behind anterior tip, in front of pallial wall. Pallial vas deferens narrow, with small posterior loop; portion of vas deferens in neck straight. Penis (Figure 13C) medium-sized, relatively narrow, weakly curved, gently tapering, inner edge somewhat swollen distally; penial tip pointed. Glandular penial lobes, 2, small, cuboidal, slightly expanded distally; glands filling distal half of lobes, discharging through rather large terminal openings. Lobe along inner edge distal, lobe along outer edge medial. Penial duct narrow, undulating throughout, positioned near outer edge. Penis pale except for small, dark area near tip.

Remarks: ***Eremopyrgus*** is assigned to the subfamily Cochliopinae (Hershler & Thompson, 1992) based on its specialized penial glands and female sperm tube separated from the glandular oviduct. This snail is distinguished from all other members of the subfamily by its unique glandular penial lobes, which bear some resemblance to those of members of the "*Heleobia* group" (Hershler & Thompson, 1992), but are cuboidal rather than spherical and do not have a large glandular lumen. ***Eremopyrgus*** further differs from the only member of the "*Heleobia* group" that broods young, *Mesobia* (locally endemic in Honduras), in having spiral (as opposed to wrinkled) protoconch sculpture, a distally pointed penis that lacks a terminal papilla, a much larger bursa copulatrix and much smaller seminal receptacle, much shorter ducts of both the bursa copulatrix and seminal receptacle, a more complexly coiled fertilization duct, and fewer brooded young. ***Eremopyrgus*** does not appear to be closely related to *Tryonia,* the only other member of the Cochliopinae reported from the Great Basin region.

Eremopyrgus eganensis Hershler, sp. nov.

Steptoe hydrobe
(Figures 3C, 12, 13A–C, 14)

Etymology: Refers to distribution of this species along the (eastern) flank of the Egan Range.

Diagnosis: As for genus.

Description: As for genus.

Type locality: spring, northwest of Clark Spring, Steptoe Valley, White Pine County, Nevada, T. 19 N, R. 63 E, NW ¼ section 20. A small rheocrene (19°C, 495 micromhos/cm) slightly disturbed by cattle (Figure 4E). Holotype, USNM 874692 (Figure 3C), collected by R. Hershler and P. Hovingh, 23 June 1992; paratypes, USNM 860759.

Remarks: ***Eremopyrgus eganensis*** lives in a group of small, closely proximate, warm springs in the southeast segment of Steptoe Valley (Figure 14).

Material examined: NEVADA. *White Pine County:* spring, northwest of Clark Spring, Steptoe Valley, USNM 860759, USNM 874692, USNM 883529, USNM 883940.—springs, Steptoe Ranch, T. 19 N, R. 63 E, SW ¼ section 5, USNM 873219.—"Big Spring," Steptoe Ranch, T. 19 N, R. 63 E, SW ¼ section 5, USNM 873204.—spring, north of Steptoe Ranch, T. 19 N, R. 63 E, NE ¼ section 5, USNM 873209.

Tryonia Stimpson, 1865a

Type species: *Tryonia clathrata* Stimpson, 1865a; original designation.

Diagnosis: Minute to large, with elongate-conic to turri-

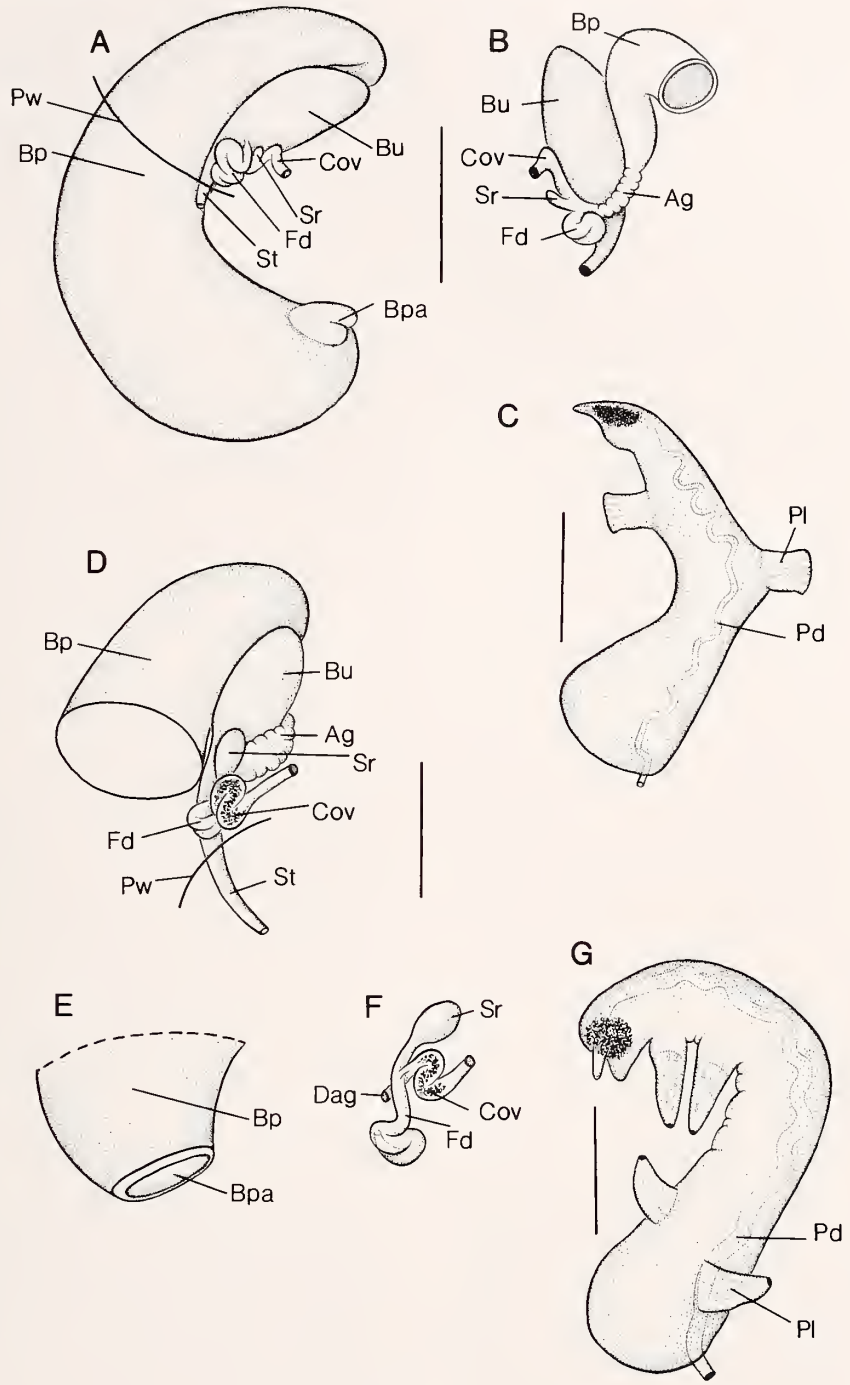


Figure 13

Genitalia of ***Eremopyrgus*** Hershler, sp. nov., and *Tryonia* species (A–C, ***E. eganensis***; Hershler, gen. & sp. nov.; D–G, ***T. monitorae,*** Hershler, sp. nov. USNM 860760). A. Left side of female glandular oviduct and associated structures, USNM 883940. Bar = 0.5 mm. B. Right side of bursa copulatrix and associated structures, USNM 883940. Scale as in "A." C. Dorsal surface of penis, USNM 874692. Bar = 0.25 mm. D. Left side of posterior portion of female glandular oviduct and associated structures. Bar = 0.125 mm. E. Left side of anterior portion of brood pouch, showing slightly muscularized opening. Scale as in "D." F. Left side of seminal receptacle and associated structures (coiled oviduct rotated to left). Scale as in "D." G. Dorsal surface of penis. Bar = 0.25 mm. Ag, albumen gland; Bp, brood pouch; Bpa, opening of brood pouch; Bu, bursa copulatrix; Cg, capsule gland; Cov, coiled oviduct; Fd, fertilization duct; Pd, penial duct; Pl, penial lobe; Pw, posterior wall of pallial cavity; Sr, seminal receptacle; St, sperm tube.

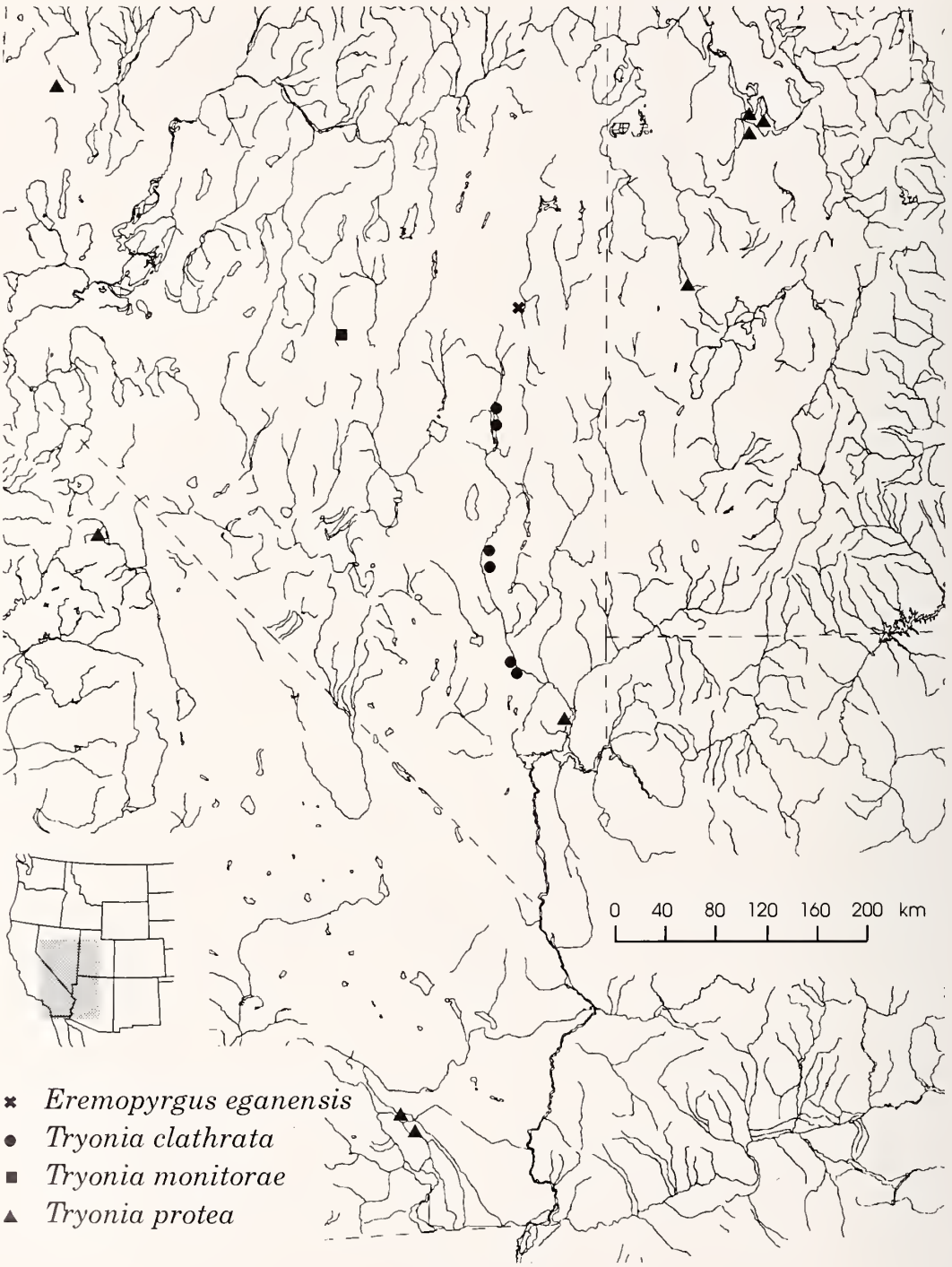


Figure 14

Map of the Great Basin (excluding northernmost portion) and adjacent regions showing the distribution of ***Eremopyrgus*** Hershler, gen. nov., and *Tryonia* species. The Mexican locality for *T. protea* is not shown.

form shell. Penis ornamented with one or more glandular papillae. Distal portion of penis having blunt, pigmented tip, a sub-terminal swelling along inner edge, and terminal papilla through which penial duct opens. Females ovoviviparous; capsule gland thin-walled, functioning as brood pouch; albumen gland highly reduced; bursa copulatrix and seminal receptacle small; fertilization duct coiled, opening to sperm tube.

Remarks: The scope and content of this genus remains poorly known as *Tryonia* has neither been subject to a modern revision nor been shown to be monophyletic. Many of the Recent species now allocated to the genus have not been well studied in terms of their anatomy. Taylor (1966b:196–198) placed numerous Recent-Tertiary high-spired species from North, Central, and South America into the genus, whereas Nuttall (1990:184–185) later questioned allocation of South American fossils to this group. Hershler & Thompson (1992) restricted the group to Pliocene-Recent species of North America.

Full descriptions of previously reported Great Basin species will be provided in a forthcoming review of this genus.

Tryonia clathrata (Stimpson, 1865a)

(Figure 14)

Tryonia clathrata Stimpson, 1865a:54, pl. 8, fig. 1.—Stimpson, 1865b:48–49, fig. 29.—Tryon, 1870:67.—Stearns, 1893:281.—Pilsbry, 1899:122.—Stearns, 1901:282.—Walker, 1918:139.—Gregg, 1941:118.—Baker, 1964: 172.—Taylor, 1966b:197.—Taylor, 1975:58 (literature compilation).—Pratt, 1977:7.—Burch & Tottenham, 1980:100, fig. 134.—Williams et al., 1985:36, 45, 48.—Hershler & Thompson, 1987:figs. 1, 11, 12, 13–15, 19, 21–23.—Turgeon et al., 1988:63.—Hershler & Thompson, 1992:110, figs. 71a,c–e, 72.

Diagnosis: A medium to large species with turriform shell; teleoconch sculpture of numerous, regularly spaced, collabral lamellae. Inner edge of penis ornamented with a single basal and four distal papillae.

Type locality: Given as "basin of the Colorado Desert," but probably in error; subfossil. Lectotype, ANSP 27969. Stimpson (1865b:48) indicated that the type material was collected by Blake during his service on one of the Pacific Railroad Surveys. Stearns (1893) disputed the type locality as this species has not been found in numerous other samples from the Colorado Desert, whereas Merriam collected living specimens from Pahranagat Valley (Nevada) well to the east. (Note that Pacific Railroad Survey expedition led by Lt. R. S. Williamson, with Blake serving as geologist, explored the Colorado Desert, but did not venture near southern Nevada [Blake, 1857].) Stearns (1901) later suggested that older Colorado Desert collections probably came from near Merriam's locality. Morrison (1940) reiterated this point and suggested that early usage of the term "Colorado Desert" probably referred more generally to the Great Basin. Taylor (1966b) suggested that the type material probably came from the Muddy River (Moapa Valley, Nevada).

Baker (1964) designated ANSP 27969a as the lectotype. Although the original label associated with this lot merely identifies it as from Stimpson's collection, with the locality, "Colorado Desert," additional material from this lot, ANSP 30778, has a label identifying Blake as the collector, with the locality given as in Stimpson's description.

Remarks: This species lives in warm springs in the White River trough (Moapa, Pahranagat, White River Valleys) in southeastern Nevada (Figure 14). Extant populations conform to "Colorado Desert" material, with shells varying from about 2.9–7.0 mm, and having 5.75–8.75 whorls. Shell sculptural development varies from low, riblike ornament (rare) to well-developed, almost spinose lamellae. Whether or not *Tryonia clathrata spiralistriata* Wessilingh, 1996, from the Pliocene of Guatemala, is closely related to extant *Tryonia clathrata* is conjectural. As noted by Wesselingh (1996), these fossils, although similar to *T. clathrata* in size, shape and collabral shell sculpture, differ in having numerous well-developed spiral lirae on the teleoconch.

Material examined: Colorado Desert, ANSP 27969, USNM 27893, USNM 30596, USNM 56403, USNM 121072, USNM 170786. **NEVADA.** *Clark County:* 9.6 km northwest of Moapa, Moapa Valley, USNM 791488.—Muddy Spring, Moapa Valley, T. 14 S, R. 65 E, NE ¼ section 16, USNM 873358, USNM 873359.—Muddy Spring, 100 m below source, Moapa Valley, T. 14 S, R. 65 E, NE ¼ section 16, USNM 874346, USNM 874790.—springs, west of Muddy Spring, Moapa Valley, T. 14 S, R. 65 E, NW ¼ section 16, USNM 874351.—spring, west of Muddy Spring, Moapa Valley, T. 14 S, R. 65 E, NW ¼ section 16, USNM 874007, USNM 874024.—spring, 0.6 km south of above, Moapa Valley, T. 14 S, R. 65 E, NW ¼ section 16, USNM 850291, USNM 873192.—"Cardy Lamb Spring," Moapa Valley, T. 14 S, R. 65 E, SW ¼ section 16, USNM 874352, USNM 874355, USNM 874788.—"Apcar Springs," Moapa Valley, T. 14 S, R. 65 E, SE ¼ section 16, USNM 874349.—"Oasis Spring," Moapa Valley, T. 14 S, R. 65 E, NW ¼ section 16, USNM 874010.—Moapa Valley Water District Spring, T. 14 S, R. 65 E, SE ¼ section 16, USNM 874018, USNM 874023.—spring, Moapa Valley National Wildlife Refuge, T. 14 S, R. 65 E, NE ¼ section 21, USNM 873356, USNM 873417, USNM 874343, USNM 874506, USNM 874787.—spring, 14.8 km northwest of Moapa, Moapa Valley, T. 14 S, R. 65 E, NE ¼ section 21, USNM 874080. *Lincoln County:* Pahranagat Valley, USNM 123621.—warm spring, Pahranagat Valley, USNM 107735. Ash Springs, Pahranagat Valley, T. 6 S, R. 60 E, NE ¼ section 1, USNM 874011, USNM 874095, USNM 874789.—Crystal Spring, Pahranagat

Valley, T. 5 S, R. 60 E, NE ¼ section 10, USNM 873157. *Nye County:* Hot Creek (source), White River Valley, T. 6 N, R. 61 E, NE ¼ section 18, USNM 873196, USNM 874306, USNM 874690.—Moorman Spring, White River Valley, T. 8 N, R. 61 E, SE ¼ section 32, USNM 873178.

*Tryonia **monitorae*** Hershler, sp. nov.

Monitor tryonia

(Figures 3D, 13D–G, 14, 15)

Etymology: Refers to endemism of this snail in Monitor Valley.

Diagnosis: A medium to large species with turriform shell often weakly sculptured with spiral threads. Penis ornamented with single basal papillae along inner and outer edges, and two distal papillae along inner edge.

Description: Shell (Figure 15A) turriform; height, 3.5–4.6 mm; whorls, 6.25–7.5. Apex flattened, often tilted; protoconch (Figure 15B) of 1.75 whorls, diameter about 0.41 mm; smooth. No obvious zone representing growth during brood period evident. Teleoconch whorls weakly to moderately convex, evenly rounded, without shoulders. Microsculpture of weak growth lines, sometimes strengthened at short intervals. Spiral threads often obvious on shells retaining periostracum; threads less obvious on cleaned shells. Periostracum brown. Shell clear. Aperture small, ovate. Outer lip thin, orthocline, often sinuate, with abapical portion advanced. Parietal lip often complete across body whorl, thin, broadly adnate. Columellar swelling absent. Shell anomphalous.

Operculum (Figure 15 C, D) thin, slightly convex, amber, ovate, paucispiral, whorls on outer surface weakly frilled; outer margin having weak rim. Attachment scar margin unthickened on inner surface. Callus absent.

Radula with about 47 rows of teeth; ribbon length, 400 μm, ribbon width, 75 μm; central tooth width, 19 μm. Central teeth (Figure 15 E, F) with moderate dorsal indentation; lateral cusps, 5–7; median cusp narrowly pointed, slightly broader and considerably longer than laterals; basal cusps, 1–2, inner cusp larger; basal tongue broad V-shaped, about even with lateral margins; basal sockets medium indented; lateral margins slightly thickened, strongly flared, often with distinct bend along outer edge, inclined about 50° to vertical axis of teeth. Lateral teeth (Figure 15G) with very slight dorsal indentation; lateral wings slightly longer (120%) than width of cutting edge; tooth face slightly taller than wide; central cusp narrowly pointed; lateral cusps 3–4 (inside), 4–6 (outside). Inner marginal teeth (Figure 15H) with 19–25 cusps; outer marginal teeth (Figure 15I) with 18–27 cusps. Cusps on inner marginals larger than those on outer marginals.

Snout, tentacles, foot, neck unpigmented to medium gray-brown. Opercular lobe black along inner edge and sides. Pallial roof light gray to near black, visceral coil pale except for black pigment on stomach, to almost entirely black on all dorsal surfaces.

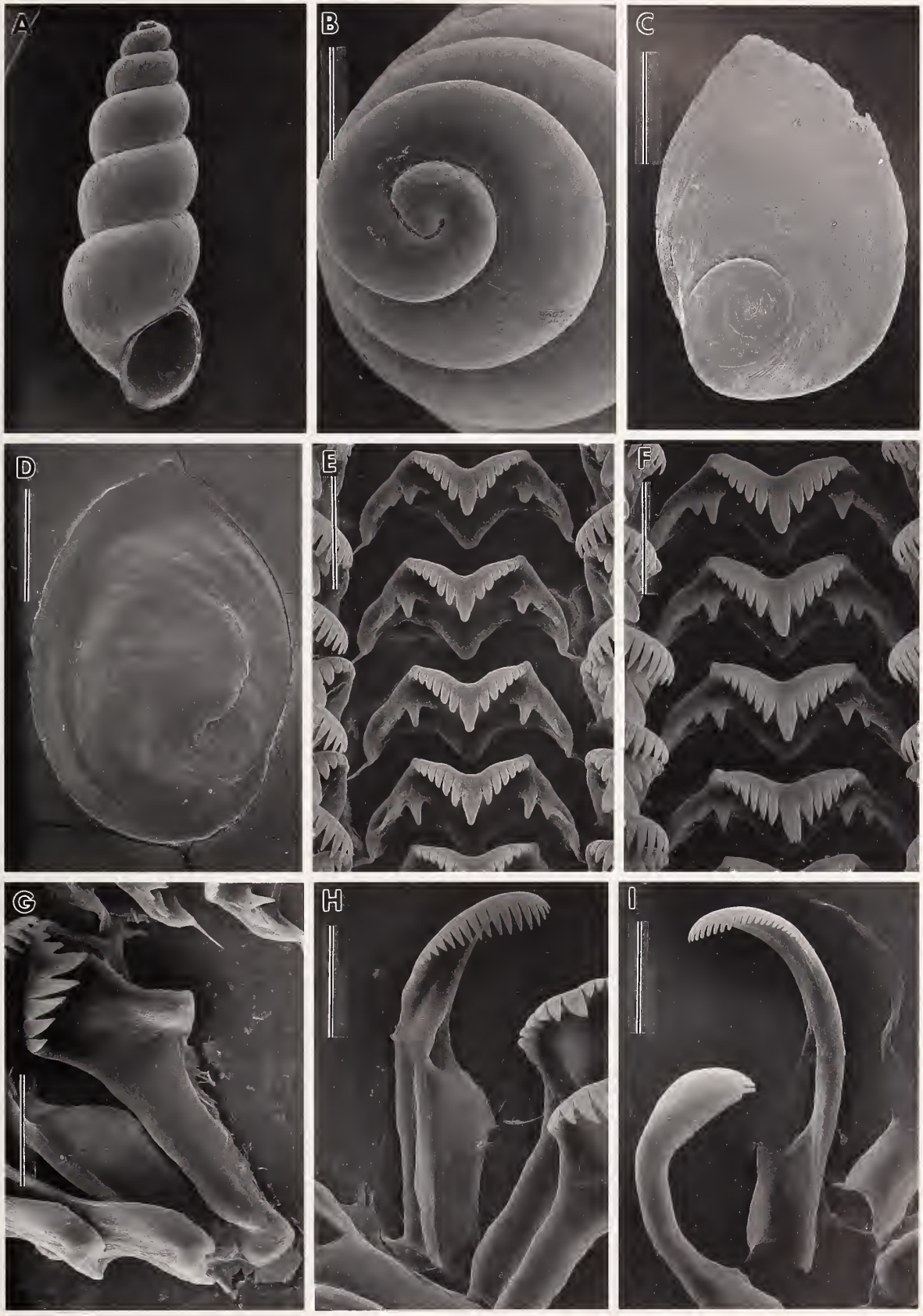
Ctenidium abutting pericardium; filaments about 35, well developed, about as tall as wide, pleated. Osphradium small (ca. 14%), positioned centrally or slightly posterior to middle of ctenidial axis. Hypobranchial gland not evident in dissection. Renal organ with moderate (30%) pallial bulge; renal opening slightly thickened. Salivary glands small, tubular. Stomach as long as style sac; anterior stomach chamber larger than posterior chamber. Cephalopedal ganglia unpigmented; cerebral commissure moderate length (ca. 43%); pedal commissure very short.

Oviduct terminating as slightly thickened tube a little behind stomach. Distal female genitalia shown in Figure 13 D–F. Coiled oviduct of two small, darkly pigmented overlapping loops (initial loop anterior-oblique, second loop posterior-oblique). Seminal receptacle a very small pouch just anterior to the bursa copulatrix (sometimes slightly overlapping left-dorsal surface). Seminal receptacle duct about as long as body, opening to coiled oviduct at point where latter connects with albumen gland. Fertilization duct of two small, tightly appressed coils opening to sperm tube (a little behind pallial wall) dorsal to coiled oviduct. Bursa copulatrix small, ovate, positioned along left-ventral side of brood pouch, extending to (or slightly posterior to) posterior edge of brood pouch, with narrow duct emerging from anterior edge; duct (to point where joined by fertilization duct) narrow, slightly longer than bursa copulatrix; sperm tube opening to pallial cavity a short distance in front of pallial wall. Brood pouch large, posteriorly folded along right side of bursa copulatrix. Pouch containing about 12 variably sized embryos; largest embryos of about 2.0 shell whorls. Albumen gland short, narrow, coursing ventrally across right side of bursa copulatrix and extending onto left side of bursa. Genital aperture broad, slightly muscularized.

→

Figure 15

Scanning electron micrographs of shell, operculum, and radula of *Tryonia **monitorae*** Hershler, sp. nov. A. Shell, USNM 860760 (height 2.6 mm). B. Shell apex, USNM 860760. Bar = 133 μm. C. Operculum, outer surface, USNM 883939. Bar = 200 μm. D. Operculum, inner surface, USNM 883939. Bar = 214 μm. E. Central radular teeth, USNM 883939. Bar = 10 μm. F. Central radular teeth, USNM 883941. Bar = 8.5 μm. G. Lateral radular tooth, USNM 883939. Bar = 10 μm. H. Inner marginal tooth, USNM 883939. Bar = 11 μm. I. Outer marginal teeth, USNM 883939. Bar = 10 μm.


A
B
C
D
E
F
G
H
I

Testis 1.5 whorl, occupying more than 50% of digestive gland behind stomach. Prostate gland small, ovate, with very short pallial component (13%). Anterior vas deferens exiting from anterior tip of prostate gland, slightly in front of pallial wall. Pallial vas deferens straight; portion of vas deferens in neck straight. Penis (Figure 13G) large, narrow, usually strongly curved, gently tapering, inner edge with pronounced bulge near terminus; penial tip rounded, with small terminal papilla. Glandular penial lobes, 4, small, conical. Basal lobes positioned on inner curvature and near outer edge. Distal lobes somewhat longer and narrower than basal lobes, positioned along inner curvature between middle of penis and distal bulge. Penial duct relatively broad, undulating except for distalmost section, positioned near outer edge. Penis pale or with light gray-brown external pigment; distal portion having small, prominent internal black patch near terminus.

Type locality: Hot Springs, Potts Ranch, Monitor Valley, Nye County, Nevada, T. 14 N, R. 47 E, NW ¼ section 1. Numerous hot springs are present in this area (Garside & Schilling, 1979:52). Snails were collected from a small thermal (34.5°C) rheocrene (Figure 4F). Holotype, USNM 892046 (Figure 2D), collected by D. W. Sada, 4 August 1996; paratypes, USNM 860760.

Remarks: This snail is restricted to the type locality and the warm (31.5°) outflow of Dianas Punch Bowl (Figure 4G). These localities are located a few km apart (Figure 14) along a fault (Garside & Schilling, 1979:52, 53). This species closely resembles *T. margae* Hershler, 1989, from Death Valley, in shell shape and penial ornament, but is larger and also differs in having periostracal spiral sculpture, fewer opercular whorls, lighter body pigmentation, a narrower basal process on the central radular teeth, and smaller radular cusps. *Tryonia* ***monitorae*** differs from all other congeners that have been studied anatomically in that the albumen gland coils onto the left side of the bursa copulatrix.

Material examined: NEVADA. *Nye County:* Hot Springs, Potts Ranch, Monitor Valley, USNM 860760, USNM 874883, USNM 883530, USNM 883939, USNM 892046.—Dianas Punch Bowl (Hot Springs), Monitor Valley, T. 14 N, R. 47 E, SE ¼ section 22, USNM 874882, USNM 883941.

Tryonia protea (Gould, 1855)

(Figure 14)

Amnicola protea Gould, 1855:129–130.—Gould, 1857:332, pl. XI:figs. 6–9.—Johnson, 1964:132.

Melania exigua Conrad, 1855:269 (*non* Morelet, 1851).

Tryonia protea (Gould, 1855), Binney, 1865:71, 72, figs. 140–142.—Tryon, 1870:68.—Berry, 1948:59, 69.—Taylor, 1966a:53–54.—Taylor, 1966b:197.—Russell, 1971:232.—Taylor, 1975:160 (literature compilation).—Burch & Tottenham, 1980:100, figs., 136, 137.—Taylor, 1981:153–154 (in part).—Taylor, 1985: 317, fig. 35 (in part).—Turgeon et al., 1988:63.—Hershler, 1989:207–208, figs. 52–54.—Hershler & Thompson, 1992:111.

Bythinella protea (Gould, 1855), Stearns, 1893:278–281 (in part).

Paludestrina protea (Gould, 1855), Stearns, 1901:277–284, pl. XIX–XXI (in part).—Hannibal, 1912:186 (in part).—Walker, 1918:138–139 (in part).—Henderson, 1924:191, fig. 94.—Chamberlin & Jones, 1929:178.—Henderson, 1929:167, fig. 176.—Jones, 1940:44.

Hydrobia protea (Gould, 1855), Henderson, 1936:139.

Pyrgulopsis imminens Taylor, 1950:28, figs. 1–3.

Pyrgulopsis blakeana Taylor, 1950:30, figs. 4–6.

Pyrgulopsis cahuillarum Taylor, 1950:31–32, fig. 7.

Diagnosis: Large, narrowly turriform, teleoconch often sculptured with spiral ridges and/or collabral ribs. Shell sculpture highly variable within and among populations, ranging from smooth to cancellate. Males unknown.

Type locality: Colorado Desert (Gran Jornado); subfossil. Syntypes, USNM 121074. Bequaert & Miller (1973: 213) suggested that the type material probably came from Riverside County (California), near Salton View.

Remarks: Extant populations tend to have weaker sculpture than subfossil material from the type locality area. The species is disjunctly distributed, with populations concentrated in the upper Owens River drainage, lower Colorado River basin, Bonneville basin, and Lahontan basin (Figure 14). Taylor (1966a:53, 54) suggested that living populations assigned to this species may be composite, but I have not found this evident based on morphologic criteria. Late Pleistocene fossil records from Ivanpah Mountains and Pahrump Valley (Roth & Reynolds, 1990; Taylor, 1986, respectively) and live collections from Gila River drainage, Arizona (Bequaert & Miller, 1973:213) and Meadow Valley Wash, Nevada (Taylor, 1986:fig. 1) require confirmation. Gregg (1941) reported this species from Moapa, Nevada, but I suspect that his material represented relative smooth-shelled variants of *Tryonia clathrata.*

Material examined (exclusive of the numerous sub-fossil records from the type locality area): MEXICO. SONORA. spring, El Doctor, Colorado River drainage, USNM 873440, USNM 874183. **CALIFORNIA.** Colorado Desert, USNM 121074. *Mono County:* Hot Creek, Long Valley, T. 3 S, R. 28 E, NE ¼ sec. 25, USNM 857954, USNM 873362, USNM 874182, USNM 883309.—Whitmore Hot Springs, Long Valley, T. 4 S, R. 29 E, NE ¼ sec. 6, USNM 874180.—spring, tributary to Little Alkali Lake, Long Valley, T. 3 S, R. 29 E, NW ¼ section 29, USNM 873364, USNM 873365, USNM 874189. *Riverside County:* warm springs near Salton, USNM 104886.—Dos Palmas Spring, Salt Creek drainage, T. 8 S, R. 11 E, NW ¼ section 3, USNM 163227, USNM 791494.—spring, ca. 1.0 km WSW of Hunters

Spring, Salt Creek drainage, T. 8 S, R. 11 E, NE ¼ section 14, USNM 873367.—Hunters Spring, Salt Creek drainage, T. 8 S, R. 11 E, SW ¼ sec. 12, USNM 873443, USNM 874194, USNM 874469.—"Oasis Spring," Salt Creek drainage, T. 8 S, R. 12 E, NE ¼ section 30, USNM 854744, USNM 873441, USNM 874196. NEVADA. *Clark County:* Blue Point Spring, Virgin River drainage, T. 18 S, R. 68 E, SW ¼ section 6, USNM 883248, USNM 883884. *Washoe County:* spring, tributary to Fly Reservoir, Hualapai Flat, T. 34 N, R. 23 E, SE ¼ section 2, USNM 892080. UTAH. *Juab County:* Percy Spring, Fish Springs Flat, T. 11 S, R. 14 W, SE ¼ section 26, USNM 854617, USNM 858283, USNM 883474.—South Springs, Fish Springs Flat, T. 11 S, R. 14 W, NE ¼ section 26, USNM 858286. *Tooele County:* Horseshoe Springs, Skull Valley, T. 2 S, R. 8 W, SE ¼ sec. 26, USNM 858291, USNM 883883.—first spring south of Josepha, Skull Valley, FMNH 178352, FMNH 224336.—spring at Josepha, Skull Valley, FMNH 178411.—spring before Josepha, Skull Valley, FMNH 178379.—Warm Springs, Tooele Valley, T. 2 S, R. 6 W, NE ¼ sec. 16.—spring, Blue Lake, Great Salt Lake Desert, T. 4 S, R. 19 N, NW ¼ sec. 7, USNM 883397.—Salt Spring, FMNH 178443, FMNH 224404.

Acknowledgments. Collecting permits were provided by the Nevada Department of Wildlife, State of Idaho Department of Fish and Game, and U.S. Fish and Wildlife Service. Loan of museum material was facilitated by G. Rosenberg (ANSP), T. Gosliner and E. Kools (CAS), and R. Bieler and J. Slapcinsky (FMNH). T. Frest, D. Giuliani, P. Hovingh, J. Landye, D. Sada, G. Vinyard, and D. Wong assisted with fieldwork and/or shared notes and material. Y. Villacampa (USNM) measured shells; prepared, studied and photographed snail morphology using a scanning electron microscope; and printed photographs. W. Brown and S. Braden facilitated use of the USNM Scanning Electron Microscopy Laboratory. K. Darrow inked anatomical drawings. M. Ryan (USNM) drew and inked shells and assisted with final map preparation. Terry Frest made helpful comments on a draft of the manuscript. Fiscal support was provided by the Smithsonian Institution (awards from the Scholarly Studies Program, and Office of the Provost), Bureau of Land Management (Bureau of Inland Fisheries), National Biological Service, and California Department of Fish and Game (Contract FG7342).

LITERATURE CITED

Baily, J. L. & R. I. Baily. 1951–1952. Further observations on the Mollusca of the relict lakes in the Great Basin. The Nautilus 65:46–53, 85–93.

Baird, W. 1863. Descriptions of some new species of shells, collected at Vancouver Island and in British Columbia, by J. K. Lord, Esq., naturalist to the British North-American Boundary Commission, in the years 1858–1862. Proceedings of the Zoological Society of London 31:66–70.

Baker, H. B. 1964. Type land snails in the Academy of Natural Sciences of Philadelphia. Part III. Limnophile and thalassophile Pulmonata. Part IV. Land and freshwater Prosobranchia. Proceedings of the Academy of Natural Sciences of Philadelphia 116(4):149–193.

Beetle, D. E. 1957. The Mollusca of Teton County, Wyoming. The Nautilus 71(1):12–22.

Beetle, D. E. 1961. A checklist of Wyoming Recent Mollusca. Sterkiana 3:1–9.

Beetle, D. E. 1989. Checklist of Recent Mollusca of Wyoming, USA. Great Basin Naturalist 49(4):637–645.

Bequaert, J. C. & W. B. Miller. 1973. The Mollusks of the Arid Southwest, with an Arizona Check List. The University of Arizona Press: Tucson. 271 pp.

Berry, E. G. 1948 ("1947"). Snails collected for the schistosomiasis investigations. United States National Institute of Health Bulletin 189:55–69.

Binney, W. G. 1865. Land and fresh-water shells of North America, III: Ampullariidae, Valvatidae, Viviparidae, fresh-water Rissooidae, Cyclophoridae, Truncatellidae, fresh-water Neritidae, Helicinidae. Smithsonian Miscellaneous Collections 7:120 pp.

Bisson, P. A. & C. E. Bond. 1971. Origin and distribution of the fishes of Harney basin, Oregon. Copeia 1971(2):268–281.

Blake, W. P. 1857. Geological report. 370 pages, 13 plates in Vol. 5, Report of explorations and surveys for railroad routes to connect with the routes near the 35th and 32d parallels of north latitude by Lieutenant R. S. Williamson, 1853; in Reports of explorations and surveys, to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean made under the direction of the Secretary of War, in 1853–4, according to acts of Congress of March 3, 1853, May 31, 1854, and August 5, 1854. A. O. P. Nicholson: Washington, D.C.

Burch, J. B. & J. L. Tottenham. 1980. North American freshwater snails. Species list, ranges and illustrations. Walkerana 1(3):81–215.

Call, R. E. 1884. On the Quaternary and Recent Mollusca of the Great Basin with descriptions of new forms. Introduced by a sketch of the Quaternary lakes of the Great Basin by G. K. Gilbert. United States Geological Survey Bulletin 11: 66 pp., plates I–VI.

Carpenter, P. P. 1864. Supplementary report on the present state of our knowledge with regard to the Mollusca of the west coast of North America. Report of the British Association for the Advancement of Science 33:517–586.

Chamberlin, R. V. & D. T. Jones. 1929. A descriptive catalog of the Mollusca of Utah. Bulletin of the University of Utah 19:203 pp., map.

Conrad, T. 1855. Description of a new species of *Melania*. Proceedings of the Academy of Natural Sciences of Philadelphia 7:269.

Garside, L. J. & J. H. Schilling. 1979. Thermal waters of Nevada. Nevada Bureau of Mines and Geology Bulletin 91: 163 pp., plate.

Gould, A. A. 1855. New species of land and freshwater shells from western (N.) America. Proceedings of the Boston Society of Natural History 5:127–130.

Gould, A. A. 1857. Catalogue of the Recent shells, with descriptions of the new species. Appendix, article 3, pp. 330–336. pl. 11 of pt. 2, Geological report, W. P. Blake, in Vol. 5, Report of explorations and surveys for railroad routes to connect with the routes near the 35th and 32d parallels of north latitude by Lieutenant R. S. Williamson, 1853, in Reports of explorations and surveys, to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean made under the direction of the Secretary of War, in 1853–4, according to acts of

Congress of March 3, 1853, May 31, 1854, and August 5, 1854. A. O. P. Nicholson: Washington, D.C.

Gregg, W. O. 1941. *Fluminicola avernalis* and *Fluminicola avernalis carinifera* from Nevada. The Nautilus 54(4):117–118.

Haldeman, S. 1840–1871. A Monograph of the Limniades or Freshwater Univalve Shells of North America. J. Dobson: Philadelphia. 231 pp.

Hannibal, H. 1912. A synopsis of the Recent and Tertiary freshwater mollusks of the Californian Province, based upon an ontogenetic classification. Proceedings of the Malacological Society of London 10:112–166, 167–211.

Henderson, J. 1924. Mollusca of Colorado, Utah, Montana, Idaho and Wyoming. University of Colorado Studies 13:65–223.

Henderson, J. 1929. Non-marine Mollusca of Oregon and Washington. University of Colorado Studies 17(2):47–190.

Henderson, J. 1936. Mollusca of Colorado, Utah, Montana, Idaho and Wyoming—Supplement. University of Colorado Studies 23:81–145.

Hershler, R. 1989. Springsnails (Gastropoda: Hydrobiidae) of Owens and Amargosa River (exclusive of Ash Meadows) drainages, Death Valley system, California-Nevada. Proceedings of the Biological Society of Washington 102:176–248.

Hershler, R. 1998. A systematic review of the hydrobiid snails (Gastropoda: Rissooidea) of the Great Basin, western United States. Part 1. Genus *Pyrgulopsis*. The Veliger 41(1):1–132.

Hershler, R. & T. J. Frest. 1996. A review of the North American freshwater snail genus *Fluminicola* (Hydrobiidae). Smithsonian Contributions to Zoology 583:41 pp.

Hershler, R. & F. G. Thompson. 1987. North American Hydrobiidae (Gastropoda: Rissoacea): redescription and systematic relationships of *Tryonia* Stimpson, 1865 and *Pyrgulopsis* Call and Pilsbry, 1886. The Nautilus 101:25–32.

Hershler, R. & F. G. Thompson. 1988. Notes on morphology of *Amnicola limosa* (Say, 1817) (Gastropoda: Hydrobiidae) with comments on status of the subfamily Amnicolinae. Malacological Review 21:81–92.

Hershler, R. & F. G. Thompson. 1992. A review of the aquatic gastropod subfamily Cochliopinae (Prosobranchia: Hydrobiidae). Malacological Review Supplement 5:140 pp.

Hershler, R., T. J. Frest, E. J. Johannes, P. A. Bowler & F. G. Thompson. 1994. Two new genera of hydrobiid snails (Prosobranchia: Rissooidea) from the northwestern United States. The Veliger 37(3):221–243.

Hinds, R. B. 1842. Descriptions of new shells. Annals and Magazine of Natural History 10:81–84.

Johnson, R. I. 1964. The Recent Mollusca of Augustus Addison Gould. United States National Museum Bulletin 239:182 pp., 45 plates.

Jones, D. T. 1940. Recent collections of Utah Mollusca, with extralimital records from certain Utah cabinets. Proceedings of the Utah Academy of Sciences, Arts and Letters 17:33–45.

Lea, I. 1838. Description of new freshwater and land shells. Transactions of the American Philosophical Society 6:1–154.

Morelet, A. 1851. Testacea novissima Insulae Cubanae et Americae Centralis. Pars II. J.-B. Baillière: Paris. 30 pp.

Morrison, J. P. E. 1940. A new species of *Fluminicola* with notes on "Colorado Desert" shells, and on the genus *Clappia*. The Nautilus 53:124–127.

Nuttall, C. P. 1990. A review of the Tertiary non-marine molluscan faunas of the Pebasian and other inland basins of north-western South America. Bulletin of the British Museum of Natural History (Geology) 45(2):165–371.

Pilsbry, H. A. 1890. Notices of new Amnicolidae. The Nautilus 4:63–64.

Pilsbry, H. A. 1899. Catalogue of the Amnicolidae of the western United States. The Nautilus 12:121–127.

Pilsbry, H. A. 1935. Western and southwestern Amnicolidae and a new *Humboldtiana*. The Nautilus 48:91–94.

Pratt, W. L. 1977. Hydrobiid snails of the Moapa warm spring complex, Nevada. Western Society of Malacologists, Annual Report 10:7. [abstract.]

Roth, B. & R. E. Reynolds. 1990. Late Quaternary nonmarine Mollusca from Kokoweef Cave, Ivanpah Mountains, California. Bulletin of the Southern California Academy of Sciences 89(1):1–9.

Russell, R. H. 1971. Mollusca of Fish Springs, Juab County, Utah: rediscovery of *Stagnicola pilsbryi* (Hemphill, 1890). Great Basin Naturalist 31:223–236.

Say, T. 1817. Descriptions of new species of land and fresh water shells of the United States. Journal of the Academy of Natural Sciences of Philadelphia 1(1):123–126.

Stearns, R. E. C. 1893. Report on the land and fresh-water shells collected in California and Nevada by the Death Valley Expedition, including a few additional species obtained by Dr. C. Hart Merriam and assistants in parts of the southwestern United States. North American Fauna 7:269–283.

Stearns, R. E. C. 1901. The fossil fresh-water shells of the Colorado Desert, their distribution, environment, and variation. Proceedings of the United States National Museum 24:271–299, pls. XIX–XXIV.

Stimpson, W. 1865a. Diagnoses of newly discovered genera of gasteropods, belonging to the sub-fam. Hydrobiinae, of the family Rissoidae. American Journal of Conchology 1:52–54, pl. 8.

Stimpson, W. 1865b. Researches upon the Hydrobiinae and allied forms; chiefly made upon materials in the museum of the Smithsonian Institution. Smithsonian Miscellaneous Collections 201:59 pp.

Taylor, D. W. 1950. Three new *Pyrgulopsis* from the Colorado Desert, California. Leaflets in Malacology 1(7):27–33.

Taylor, D. W. 1966a. Summary of North American Blancan nonmarine mollusks. Malacologia 4:172 pp.

Taylor, D. W. 1966b. A remarkable snail fauna from Coahuila, México. The Veliger 9:152–228.

Taylor, D. W. 1975. Index and bibliography of Late Cenozoic freshwater Mollusca of western North America. University of Michigan Museum of Paleontology, Papers on Paleontology 10:384 pp., errata (March, 1976). [Claude W. Hibbard Memorial Volume 1.]

Taylor, D. W. 1981. Freshwater mollusks of California: a distributional checklist. California Fish and Game 67(3):140–163.

Taylor, D. W. 1985. Evolution of freshwater drainages and mollusks in western North America. Pp. 265–321 in C. J. Smiley & A. J. Leviton (eds.), Late Cenozoic History of the Pacific Northwest. American Association for the Advancement of Science: San Francisco.

Taylor, D. W. 1986. Fossil molluscs from the Lake Hill archeological site, Panamint Valley, southeastern California. Pp. 42–54 in E. L. Davis & C. Raven (eds.), Environmental and Paleoenvironmental Studies in Panamint Valley. Contributions of the Great Basin Foundation 2.

Taylor, D. W. & R. C. Bright. 1987. Drainage history of the

Bonneville Basin. Pp. 239–256 in R. S. Koop & R. E. Cohenour (eds.), Cenozoic Geology of Western Utah: Sites for Precious Metal and Hydrocarbon Accumulations. Utah Geological Association Publication 16.

Thompson, F. G. & R. Hershler. 1991. Two new hydrobiid snails (Amnicolinae) from Florida and Georgia, with a discussion of the biogeography of freshwater gastropods of south Georgia streams. Malacological Review 24:55–72.

Troschel, F. H. 1856–1863. Das gebiss der shnecken zur bergründung einer natürlichen classification. Vol. 1. Nicolaische Verlagsbuchhandlung: Berlin. 252 pp.

Tryon, G. W. 1865. Descriptions of new species of *Amnicola, Pomatiopsis, Somatogyrus, Gabbia, Hydrobia* and *Rissoa.* American Journal of Conchology 1:219–222 + plate 22.

Tryon, G. W. 1870. A Monograph of the Fresh-Water Univalve Mollusca of the United States: Turbidae, Physadae. Part 1. [Conchological Section of] Academy of Natural Sciences of Philadelphia: Philadelphia. 82 pp.

Turgeon, D. D., A. E. Bogan, E. V. Coan, W. K. Emerson, W. G. Lyons, W. L. Pratt, C. F. E. Roper, A. Scheltema, F. G. Thompson & J. D. Williams. 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. American Fisheries Society Special Publication 16:277 pp., 6 plates.

Walker, B. 1918. A synopsis of the classification of the freshwater Mollusca of North America, north of Mexico, and a catalogue of the more recently described species, with notes. University of Michigan Museum of Zoology Miscellaneous Publications 6:213 pp.

Wesselingh, F. P. 1996. Geological-paleontological research in the Tertiary and Quaternary of Central America III. New Pliocene fresh-water gastropods from Guatemala. Documenta Naturae 100:23–36.

Williams, J. E., D. B. Bowman, J. E. Brooks, A. A. Echelle, R. J. Edwards, D. A. Hendrickson & J. J. Landye. 1985. Endangered aquatic ecosystems in North American deserts with a list of vanishing fishes of the region. Journal of the Arizona-Nevada Academy of Science 20:1–62.